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CONTENTS:

It does seem as though a great deal of time and energy are wasted in some sessions of the Maintenance of Way Association in discussions of the Manual. One is at times reminded of the chronicle of the proceedings of the French Academy, which, for the past hundred years, have read: "The Academy held a session last evening. They were engaged upon the dictionary." No one expects the dictionary to be finished. So to some it seems the chronicle of the proceedings of this association might read: "The association met. They were engaged on the Manual." The Manual is very valuable, but, after all, is only recommendatory and carries no obligation to use it, and much of the time spent in its compilation might well be more profitably employed in discussing some of the really excellent work that has been done in committee. For instance, to ignore such an important and masterly piece of work as the impact tests and spend time in discussing the verbiage of a proposal regarding the unloading of material looks like subordinating what is very important to what is relatively unimportant. It is not possible that all of the knowledge on a subject is embodied in the reports, excellent as they are, and even if such were the case, it seems as though the association ought at least to extend the courtesy of a discussion to those who have done such good work. The association in giving so much discussion to the Manual is apt to deprive its members of golden opportunities for personal and professional improvement.

The statistics recently published, giving the production of rails in the United States for 1910, are of much interest as indicating a gradual change in the composition of the rails being rolled. While the production of all kinds of rails for the year did not reach that of the maximum year 1906, when nearly 4,000,000 tons were rolled, the total was 3,634,029 tons, an increase of 20.1 per cent. over 1909. Of this 1,715,900 tons were of open-hearth steel, as compared with 1,256,674 tons of this steel rolled the previous year, or an increase of 36½ per cent. The tonnage of special alloy steel rails rolled in 1910 amounted to 200,621, of which 195,408 tons were titanium and 390 tons were manganese steel, as compared with only 50,724 tons of all kinds of special alloy steel rails rolled in 1909, or an increase of over 330 per cent. The amount of Bessemer rails rolled last year reached a total of 1,917,900 tons, or an increase of but 8½ per cent. over 1909. These figures indicate the growing dissatisfaction with the Bessemer rail, which has been rolled during recent years, and the growing realization of the necessity of securing some other steel. While but little of the open-hearth or special alloy rail has been in track long enough for reliable data to be secured concerning their service, the unsatisfactory service of the Bessemer rail is fully known. The necessity of getting a better rail is so pressing that the railways are more than usually willing to investigate new materials, and the very great increase in the rolling of special alloy steel rails has an instructive bearing on this phase of the subject. Largely untried as they are in service, this increase of over 300 per cent. in their manufacture shows how strong is the feeling of the railways that they must get some other and better material. In spite of the increased cost, they are willing to pay the price for these newer rails, in the hope of getting really satisfactory steel. The original cost of the rail is but a proportion of its total cost. The greater danger of accident, together with the increased vigilance and patrol they make necessary, and the greater cost of replacement their use involves, all tend to offset the lower initial cost of inferior rails.

While the committee on economics of railway location was largely unable to accomplish the work it set out to do during the past year, an investigation which bears promise of giving very important results has nevertheless been carried on under its supervision in the study of train resistance on the Baltimore & Ohio. When the data secured in these tests is worked up and the results published, they will undoubtedly bring out some very valuable facts. Work of this nature is of the greatest importance to the railways, as it directly affects the actual cost of the conducting of their main business—the transportation of traffic. Tests were carried on to ascertain the resistances of trains under various speeds and also in starting after long and short stops. From these studies, as well as from the results of investigations reported last year, it appears so far that the resistance varies but little for changes in speed between 5 and 35 miles per hour. The effect of stops, both long and short, on train resistance has been but lightly touched on as yet. This offers an important field for further investigation, for the starting resistance may be the limiting factor in determining tonnage rating. The question has been raised as to what is the lowest rate to which it is practicable to reduce the gradient. A more thorough investigation of this initial train resistance will largely help in answering this question. In discussing these tests, Mr.

Begien described one test with a freight train leaving the Newark, Ohio, yard of the Baltimore & Ohio, where a pusher was necessary to start the train out of the yard. The resistance reached 20 lbs. per ton and did not fall to the normal until the train had been out of the yard about two hours. As a result of this test, in the construction of new yards at two different points the Baltimore & Ohio has reduced the grades below the ruling grade for some distance out of the yard to equate for this initial resistance, since it is especially important that the trains move readily just out of the terminals. This indicates another important point to be considered in laying out grade line.

THE MANUAL AND CURRENT PRACTICE.

The question is worthy of the serious consideration of the association whether too many details of methods and structure are not being adopted as recommended practice and, as such, put into the Manual. The American Railway Engineering and Maintenance of Way Association is the great authority on all matters pertaining to railway engineering and maintenance of way in North America. Its word is generally regarded—and properly so—as the last word on all the subjects with which it deals. When it adopts anything as recommended practice, it is bound to be generally assumed—whether the association desires it to be or not—that this has been done, not merely because the association regards the thing in question as good practice, but because it regards it as the best practice. This being true, it would seem that only those things should be adopted as recommended practice which the association regards as (1) of very material importance, and (2), not as the best ideal practice, but as the best practice that will be practicable under the actual conditions with which railway engineers have to deal to-day.

Now, in many cases the association has not conformed to this rule. It has adopted, and still is adopting, numerous things as recommended practice which are of relatively minor importance. It also has adopted as recommended practice numerous things, which, if we may judge by the action of a great majority of the roads, are not regarded as improvements or essential. Numerous methods and devices have been recommended in the Manual which were being used at the time by only a small minority of railways, and which were not subsequently adopted by any considerable number of them. Now, in these cases one of two things has been true: Either the practice recommended has not been widely adaptable to the actual conditions with which the railways have to deal, or the railways have been greatly at fault in not making their practice conform to them. Suppose an accident happens which can, by any stretch of the imagination, be attributed to the use of a method or device which has been employed contrary to the judgment of the association as expressed by the Manual, but some person who is injured sues the railway concerned for damages. It may very well be that the method that has been employed or the device that has been used is actually more expensive and better than the recommended practice, but juries know nothing about these technical matters, and the introduction of evidence showing that the practice on which the association had set the seal of its approval had not been conformed to would in most cases be enough to cause the road to be mulcted in damages. Again, government regulation is rapidly being extended to every detail of railway operation. When the legislatures and commissions decide to do some regulating of construction and maintenance they naturally will turn to the Manual for light on what requirements they shall impose. They have a right to assume that whatever the association has recommended as standard is both good and entirely practical; and the railways are apt to wake some morning and find that they have been required by statute to do certain things at once, and at great expense, which have been set up merely as high ideals to be aimed at and which those who recommended them expected to approach only gradually and did not expect to be attained for years.

It is not intended to imply that there should be any hesitation about adopting as recommended practice any method or device which is of first-rate importance and which experience has shown to be desirable. Standards regarding numerous matters are very desirable, because when many railways buy standard articles the makers can turn them out at relatively low cost to themselves and at relatively low prices to the purchasers. For example, there should be great insistance on a high standard of recommended practice for the manufacture of steel rails, bridge timber, cement, etc., and a stronger insistence than there has been in the past on the manufacturers making such materials and supplies according to specifications. But is it not a mistake to specify one location of a freight house with reference to the tracks as preferable to any other arrangement, and to specify a platform on the track side, when local conditions very generally decide what is best and the recommended plan may be entirely unsuited to many locations? Again, the Committee on Water Service recommended the dome roof for specification for wooden water tanks, whereas this is but one of several styles of roofs that are equally good. It would seem that in such cases as this it would be better to accept the committee's report as information—valuable information, indeed, when investigations have been as thorough as they ought to be, and as many are—but nevertheless, so far as the association is concerned, merely information. It has been suggested that perhaps it might be well to embody such recommendations of committees in a separate volume merely for the information of members of the engineering profession, and include such material as—while important—is not in wide enough use to warrant its being recommended practice. The recommendations of a committee of a half dozen or a dozen members, however able and painstaking, are a very different matter from a recommendation by the united voice of the association. There is nothing to prevent the roads from acting individually on such recommendations; but unless the matters dealt with are of very material and the recommendations entirely practical in view of existing conditions, it would seem that the association itself ought not definitely to commit itself to them.

RAIL SPECIFICATIONS.

Conditions relating to the manufacture of rails to specifications approved by the railways do not appear to be any more favorable or encouraging than in the past two or three years. At the last convention of the Maintenance of Way Association the rail committee reported that as far as was known no railway had purchased rails to specifications during the past two years which were entirely satisfactory. Conditions during the past year have not materially changed, and it is safe to say that 90 per cent. of the roads which have ordered rails have agreed to accept rails made under the steel manufacturers' specification. The Pennsylvania Railroad, the New York Central and the Canadian lines are the principal exceptions, and these roads, after some degree of stubbornness in insisting on rails made to their own ideas as to specifications, have been able to secure some changes in the right direction.

The principal feature of the American Railway Association

specification, which is the cause of dispute with manufacturers, and which has not yet been accepted by them, is the clause requiring all test pieces which do not break under the drop to be nicked and tested to destruction, and steel manufacturers are not yet willing to permit the rejection of rails which are shown to have physical defects revealed by this opportunity to examine the structure of the broken test pieces. It has been already demonstrated that good rails can be made having either the A or B section, but the adoption of these sections is not sufficient to secure the manufacture of sound rails, and the principal difficulty now is to eliminate mechanical defects due to poor methods in the manufacture of the steel ingots. The work which has already been done by some of the railways in having rails nicked, broken and tested to destruction has furnished abundant proof that some defects which are found in these test pieces sooner or later appear in an exaggerated form in the broken rails.

Rail failures, as revealed by records relating to rails of recent manufacture, may be divided into two classes; first, those in which the rail is completely broken in pieces, indicating a brittle steel; and, second, those in which the head is crushed or split. The former are caused by irregularity in the composition of the steel, due to carbon and phosphorus much higher than the specifications, which produces brittleness. The defects in the head are mechanical ones, which can be traced back to segregation, dirt and gas in the ingots which, rolled out into the head, still remain as seams which are not completely closed up. Rails having a composition showing too much carbon and phosphorus should be detected under the drop; and if they are not, the drop should be adjusted so that it will detect such defects, and a sufficient number of test pieces made to discover the brittle rails in any heat. The defects of most rails which fail on account of crushed and split heads could be detected by a stricter enforcement of the specification requiring an inspection of the fracture after sample has been nicked and broken.

The use of carbon up to .83 per cent. in open hearth rails, with phosphorus .03 per cent., has resulted in a good wearing steel, but where the carbon is so near the critical point the process of manufacture must be watched more carefully. A good wearing rail can only be made by unusual care in the manufacture of the steel; the problem of making rails free from physical defects, once partially attributable to the rail section, is almost entirely dependent on proper methods in the manufacture and treatment of the steel ingots.

The committee on rail reports only progress in the preparation of a specification, and it thinks it necessary to carry on more tests and experiments before recommending a final specification. Judging from the size of the report on rails this year, there is danger of becoming buried in statistics and accumulating a mass of material relating to steel manufacture which from its mere bulk will render more hopeless a final conclusion as to a proper specification.

Sufficient information is now at hand for the preparation of a specification which, if faithfully followed by the steel works and mills, would produce satisfactory rails, and at a cost which would secure to the manufacturer an ample profit. Most rail defects can be traced in one way or another to rapid manufacture; sufficient time is not allowed for the steel to settle in the ladle or for it to soak to a uniform temperature in the pit, and there is also too rapid reduction in the rolls. The time element is the most important one which needs adjustment. It is unfortunate, therefore, that the past few months have been virtually wasted in the output of rails, and the year's requirements will be turned out in six months at high speed with no improvement in quality. If the orders could be so placed that the mills could be operated steadily on a smaller output per day and at a slower rate in all processes of manufacture, the quality of the product would improve and many of the defects which are now shown up with such apparent satisfaction by some investigators would disappear.

The advantage of slower methods in rail manufacture is shown by the results obtained in the countries north and south of us. In Canada and Mexico, where the converters are not on such a grand scale or the mill machinery so ingenious and powerful, the quality of the rails produced is much superior to the average rail made in the United States.

The roads represented in the American Railway Association could do more toward securing improvement of American rail manufacture and reduction in the number of defective rails by giving the mills sufficient orders to keep them running steadily at moderate speed than it will ever accomplish by tests and analyses and the publication of vast tomes of reports on defective rails.

PROGRAM.

(Order may be changed by a two-thirds vote of convention or by time required for consideration of reports.)

Thursday, March 23.

Morning session, 9 a. m. to 12:30 p. m.
Afternoon session, 2 p. m. to 5:30 p. m.

XIII. Water Service.
IX. Signs, Fences and Crossings.
XI. Records and Accounts.
XVII. Wood Preservation.
Special: Grading Rules for Maintenance of Way Lumber.
VI. Buildings.
I. Roadway.
Special: Uniform General Contract Forms.
XIX. Conservation of Natural Resources.
New Business.
Election of Officers.
Adjournment.

RAILWAY PASSES GOOD AT THE COLISEUM.

It should be remembered by railway men that their passes are good for admission to the Coliseum any time during the week. It is only necessary to show them at the door, and separate admission tickets are not necessary.

MEETING OF BOARD OF DIRECTORS.

A meeting of the board of directors of the American Railway Engineering and Maintenance of Way Association will be held in Room 1166 at the Congress Hotel immediately after the adjournment of the convention today.

PROFESSOR PENCE COMING TODAY.

Prof. W. D. Pence of the University of Wisconsin, editor of the Proceedings of the American Railway Engineering and Maintenance of Way Association, is expected to arrive in Chicago in time to attend at least the afternoon session of the Association today. Professor Pence has been in Panama but is trying to get here before the adjournment.

LUNCHEON TO B. & O. MEN ATTENDING THE CONVENTION.

A. W. Thompson, general manager of the Baltimore & Ohio, gave a luncheon at the Congress Hotel yesterday to 50 officers of this road who are attending the Maintenance of Way convention. After the luncheon brief talks were made by Mr. Thompson; Francis Lee Stewart, chief engineer; J. E. Greiner, consulting bridge engineer; Earl Stimson, chief engineer maintenance of way; F. P. Patenall, signal engineer; and Major Pangborn, of the president's

staff. President Willard was in the city and expected to attend the luncheon but was called away by business. Mr. Thompson, in his remarks, urged the Baltimore & Ohio men individually and collectively to take an interest in the work and participate in the discussions of the Association, saying that this would be beneficial both to them personally and to the road. It is an interesting fact that the Baltimore & Ohio has more representatives among the members of the Association than any other railway. Mr. Thompson is among them, being a director in the Association.

STUDENTS VISIT THE EXHIBIT.

Students from the technical schools in and near Chicago are finding the Coliseum a great attraction this week, and many of them are taking advantage of the opportunity there presented to see the latest and best in railway supplies. Northwestern University, Armour, Purdue, Illinois, Wisconsin and Indiana are particularly well represented.

LARGE CROWD AT THE COLISEUM.

The attendance at the Coliseum on Wednesday afternoon broke all records for this year, and compared favorably with even the highest attendance last year. During the latter part of the afternoon, especially, the exhibits both on the ground floor and in the balconies were well filled. The association adjourned soon after 4:00 o'clock, and many of the members went to the Coliseum.

NEW PURCHASING AGENT OF THE NEW YORK CENTRAL.

Sydney B. Wight, purchasing agent of the New York Central & Hudson River, has been appointed general purchasing agent, succeeding F. H. Greene, whose resignation has been announced in the Railway Age Gazette. W. C. Bower, chief clerk in the office of the president, succeeds Mr. Wight, with office at New York.

A MEMBER CRITICIZES ENTERTAINMENT FEATURES OF THE SMOKER.

W. F. Steffens, engineer of structures of the Boston & Albany, yesterday sent the following letter to President L. C. Fritch:

Chicago, March 22, 1911.

Mr. L. C. Fritch, Pres. American Railway Engineering and Maintenance of Way Association,
Chicago, Ill.

Dear Mr. Fritch:—

Following out the policy of the association as to full discussion of the various matters affecting its interests, I should like to present a personal view of the "smoker" held Tuesday evening.

The fundamental idea of the "smoker," so well known in engineering societies, is an informal gathering at which members and their guests may mingle for conversation and light entertainment, with the usual accessories of refreshments and smoking included. The idea of this association incorporating a "smoker" evening is thoroughly appreciated by the members.

As an individual member, voicing, however, the thought of several other members, I wish to emphatically protest against a recurrence of such vaudeville and low-class comedy features as were introduced last night. It savors too strongly of the ten-cent theatre variety, and in the opinion of some is vulgarity at its best. For future "smoker" entertainments I would suggest that if music is to be provided this be of a high class order as opposed to the street band and hurdy-gurdy sort.

For one, I feel that the entertainment (?) of last evening was an infliction that prevented the members from holding conversation as they had expected would be possible from the announcement.

I have expressed my views freely in the hope that they will be received in the same spirit with which sent, and in the further hope that future entertainments will be of a higher order, as suggested.

Yours very truly,

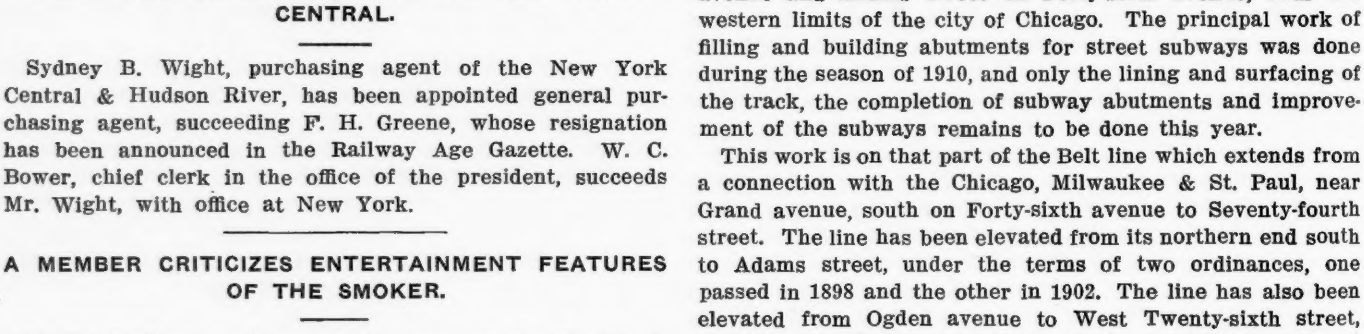
W. F. STEFFENS.

CHICAGO & WESTERN INDIANA TRACK ELEVATION ON FORTY-SIXTH AVENUE, CHICAGO.

The Chicago & Western Indiana is at present completing the work of elevating its Belt Railway tracks between Ogden avenue and Adams street on Forty-sixth avenue, near the western limits of the city of Chicago. The principal work of filling and building abutments for street subways was done during the season of 1910, and only the lining and surfacing of the track, the completion of subway abutments and improvement of the subways remains to be done this year.

This work is on that part of the Belt line which extends from a connection with the Chicago, Milwaukee & St. Paul, near Grand avenue, south on Forty-sixth avenue to Seventy-fourth street. The line has been elevated from its northern end south to Adams street, under the terms of two ordinances, one passed in 1898 and the other in 1902. The line has also been elevated from Ogden avenue to West Twenty-sixth street, provision for this work being made in an ordinance passed September 30, 1882, by the town of Cicero prior to its annexation to the city of Chicago. In addition to the two street subways included in this latter piece of elevation, there is an overhead crossing with the four-track line of the Chicago, Burlington & Quincy just south of Ogden avenue. The work that is now being completed was provided for in an ordinance passed October 22, 1906. It will connect the two sections previously elevated, making a continuous grade on high level from Grand avenue to Ogden avenue.

The Belt line handles a very heavy interchange traffic which requires large classification yards, and to meet the additional requirements in this vicinity a new 23-track yard was built on the new elevation between West Twelfth and West Twenty-



Plan of Track Elevation Work on the Belt Railway of Chicago.

second streets. The accompanying map shows a sketch of the layout of the yard, which is of the "push and pull" type, laid on a level grade. It will have a capacity of 2,000 cars. A water tank, coaling station and cinder pits will be provided at the south end of the yard to care for the switching engines, and switchmen's, car inspectors' and agents' buildings will be provided near West Twenty-second street. The Metropolitan West Side Elevated maintains a coal storage yard adjoining the south end of the Western Indiana yard, coal being delivered from a switching track east of the northbound main track of the Western Indiana. Team tracks are provided at the north end of the yard just south of West Twelfth street.

The building of the yard involved no particular difficulty, as it was only necessary to keep two through tracks open for traffic. A trestle was built from which to start the fill. By shifting the service tracks from one side to the other, the filling was carried on without interrupting traffic. Outside of the yard the method of raising one track at a time and diverting traffic to the other was used. The sand for filling was handled by the railway company in side dump gondolas from Dune Park, Ind., a distance of about 50 miles. The total fill amounted to about 700,000 yds.

The elevation work included the building of 14 subways, two of which were for steam railway crossings, one for the crossing of the Metropolitan Elevated and one for a private subway at the plant of the Western Electric Company. One of the steam railway subways is to provide for the separation of grades at the main line crossing of the Baltimore & Ohio Terminal Transfer. All clearances in street subways are 12 ft. on streets without car lines and 13½ ft. where surface cars must be provided for. The subways are of the Western Indiana's standard concrete abutment and I-beam type, the only special work being at the skew crossing provided for the Baltimore & Ohio Terminal Transfer "Y" connection and the private Western Electric subway.

CHICAGO & ALTON TRACK ELEVATION IN CHICAGO.

An ordinance was introduced in the city council of Chicago last Monday evening for the elevation of the tracks of the Chicago & Alton from South Albany avenue to beyond Kedzie avenue, Chicago, a distance of about three-quarters of a mile. The terms of this ordinance have been agreed to by both the city track elevation department and the railway company, and it probably will be formally passed at the next meeting of the council. Under its provisions the main tracks must be elevated on a temporary structure at Kedzie avenue by September 30 of this year, to provide for the construction of a street car line. By November 30, 1912, the main tracks must be elevated at Washtenaw, California and South Albany avenues, and all main and yard tracks at Kedzie avenue. While only four tracks are to be elevated under this ordinance, eventually the entire Brighton Park yard will be raised. The estimated cost of the work under the main line, including subways, is $750,000, while $500,000 additional will be required for the elevation of Brighton Park yard.

FROM ALL THE FOUR CORNERS OF THE EARTH.

Some very widely separated parts of the world are represented by men who are attending the meeting of the Maintenance of Way Association. Two of the speakers at the dinner last night were William P. Poland, who is from the Philippine Islands, and Sir Thomas R. Price, from South Africa. Among those who come from widely separated parts of North America are G. A. Mountain, chief engineer of the Canadian railway commission, Ottawa, Ont.; B. A. Wood, chief engineer of the Mobile & Ohio, Mobile, Ala.; R. J. Arey, engineer on the Coast Lines of the Santa Fe, Los Angeles, Cal., and Sherman Smith, assistant engineer of the Grand Trunk Pacific at Earl, Sask.

Proceedings.

The Wednesday morning session of the American Railway Engineering and Maintenance of Way Association was called to order at 9:30 o'clock, by President Fritch.

BALLAST.

The following sub-committees were appointed:

Revision of Manual: F. J. Stimson, chairman; W. J. Bergen, C. B. Brown, Jr.

Completing Physical Tests of Stone for Ballast: F. J. Bachelder, chairman; C. S. Millard, C. T. Brimson.

Proper Thickness of Ballast: H. E. Hale, chairman; J. M. Egan, S. N. Williams.

Review Report on Gravel Ballast: J. M. Meade, chairman; J. S. Lemond, C. C. Hill, G. D. Hicks.

REVISION OF MANUAL.

A few minor changes in wording were recommended.

PROPER THICKNESS OF BALLAST.

Some of the reasons for the use of ballast in track construction are:

(a) To provide drainage which will lead any water that may accumulate away from the ties; or to provide a protection for the subgrade from water, as in the case of cementing gravel.

J. V. Hanna,
Chairman, Committee on Ballast.

(b) To distribute the load from the ties more uniformly over the subgrade than would be done if the ties rested directly upon the subgrade.

(c) To provide a material which can readily be "worked" or tamped in all kinds of weather and which will not materially lose its carrying power or change its position as a result of the action of the elements.

The proper depth of ballast under the ties will depend, among other things, upon the following:

(a) The character of the subgrade: (1) rock, (2) firm material, as firm gravel, (3) soft material, as gumbo; (b) the kind of ballast; (c) the number and size of ties per rail length; (d) the stiffness of the rail; (e) the weight and magnitude of the wheel load and the number of applications in a given period; (f) the cost of materials used in construction of the track.

Character of Subgrade.—If the subgrade is of rock it will not be deformed by wet weather and it will carry all the load that can be put upon it by a timber tie; therefore, the depth of ballast required in this case is only sufficient to provide an equal bearing under the tie and sufficient material for tamping purposes.

If the subgrade is soft, then it is necessary to provide a depth of ballast which will produce as nearly as possible a uniform pressure on the subgrade.

Between solid rock and soft material, such as gumbo, there exists material used for subgrade of various capacity for supporting the load of the track. The softer the ma-

terial used in the subgrade, the deeper should be the ballast (within certain limits), to provide as uniform pressure on the subgrade as possible.

Kind of Ballast.—The required depth of ballast under the tie is not materially affected by the kind of ballast, although it is generally the practice to provide a less depth

Name of Railroad.	Height and Slope of Shoulder.	Width of Roadbed.				Remarks.
	Dist. from Top of Tie to Top of Shoulder.	Slope.	Cuts.	Fills.	Tile Drains.	
Baltimore & Ohio	1½ in. 1½ in. 1½ in.	c1½ to 1 1½ to 1 1½ to 1	18 ft. 16 ft. 14 ft.	20 ft. 18 ft. 16 ft.	....	
Boston & Maine	1 in. Bottom of tie	1½ to 1 Curved	19 ft. 5 in. 18 ft.	19 ft. 5 in. 18 ft.	....	
Canadian Pacific	Top tie rock Others 1 in.	Curved Curved	16 ft. 14 ft.	16 ft. 14 ft.	....	
Chicago & Alton	Top tie rock, bot. gr'v'l	1¼ to 1 curved	18 ft.	18 ft.	....	
Chicago, Burlington & Quincy	1½ in.	Rock 1½ to 1 Others 2 to 1	18 ft.	18 ft.	6 & 8 in. pipe under ditch	
Chicago Great Western	Top of tie, bot. for cementing gravel	1¾ to 1 1¾ to 1 1¾ to 1	20 ft. 18 ft. 16 ft.	20 ft. 18 ft. 16 ft.	....	
Chicago, Milwaukee & St. Paul	1½ in. 1½ in. 1½ in.	2 to 1 2 to 1 2 to 1	....	....	....	
Denver & Rio Grande	About 1 in. About 1 in. About 1 in. About 1 in.	Curved Curved Curved Curved	18 ft. 18 ft. 18 ft. 18 ft.	20 ft. 20 ft. 20 ft. 20 ft.	....	
New York, New Haven & Hartford	Top tie rock Others 3 in.	1-1 rock 2-1-others	16 ft.	16 ft.	....	
Pennsylvania	Top rock and cinder 1 in. above bot. gravel	1½ to 1	14 ft. 8½ in.	21 ft. 8½ in.	6 in. C. I. pipe cross drain	
Rock Island Lines	1½ in. 1½ in. 1½ in.	2 to 1 2 to 1 2 to 1	20 ft. 18 ft. 16 ft.	20 ft. 18 ft. 16 ft.	Cross drain where needed	
St. Louis Southwestern	Top tie rock, bot. sand	1½ to 1	17 ft.	18 ft.	....	
St. Louis & San Francisco	1½ in. 1½ in. 1½ in.	2 to 1 2 to 1 2 to 1	20 ft. 18 ft. 16 ft.	20 ft. 18 ft. 16 ft.	....	
Texas & Pacific	1 in. from bottom, top tie rock	1½ to 1 1 to 1 rock	18 ft.	15 ft.	....	
Wabash	Top of tie Top of tie	Curved Curved	18 ft. 16 ft.	18 ft. 16 ft.	....	

Remarks:

a Includes hard slag.
b Incl. granulated slag.
c Slope is being changed from c'rv'd to 1½ to 1.
d Roadbed has transverse slope ¾ in. to 1 ft. In wet ledge cuts, depth of ballast is sometimes increased to 2 ft.
e Includes furnace slag.
f Cinders used in sidetracks only.
g Includes burned clay. Ballast varies from 3 in. in sand to 18 in. in clay.
h Includes burned gumbo. Depth of ballast varies from 6 in. to 12 in. with local conditions and variation in volume of traffic.
k Rock used on double and 4 track. Only 4-track section shown; sub-grade had transverse slope ¼ in. to 1 ft.
m Includes slag and disintegrated granite.
n Includes chats. Depth of ballast varies with nature of soil.
* Shoulder is dressed to bottom of tie in cementing gravel.
o Includes slag and disintegrating granite.
p Includes chats. Depth of ballast varies with nature of soil.
* Variation from standard made account of scant supply of ballast.
r Kind of ballast not stated. Standard not followed in sidetracks.

DEPTH OF BALLAST UNDER TIE.

Name of Railroad.	Class of Track.	Center of Tie—Kind of Ballast.				End of Tie—Kind of Ballast.			
		Rock.	Gravel.	Cinders.	Sand.	Rock.	Gravel.	Cinder.	Sand.
Baltimore & Ohio	A B C	a12 in. 9 in. 6 in.	b12 in. 9 in. 6 in.	12 in. 9 in. 6 in.	....	a12 in. 9 in. 6 in.	b12 in. 9 in. 6 in.	12 in. 9 in. 6 in.	....
Boston & Maine	A Bd	....	12 in. 12 in.	....	....	....	12 in. 15 in.	....	....
Canadian Pacific	A B	7 in.	7 in. 7 in.	7 in. 7 in.	....	9 in.	9 in. 9¼ in.	9 in. 9¼ in.	....
Chicago & Alton		e12 in.	12 in.	f12 in.	....	e13½ in.	13½ in.	f12 in.	....
Chicago, Burlington & Quincy		8 to 12 in.	8 to 12 in.	8g to o12 in.	....	8 to 12 in.	8 to 12 in.	g8 to 12 in.	....
Chicago Great Western	A B C	12 in. 9 in. 6 in.	12 in. 9 in. 6 in.	12 in. 9 in. 6 in.	....	13 in. 10 in. 7 in.	13 in. 10 in. 7 in.	13 in. 10 in. 7 in.	....
Chicago, Milwaukee & St. Paul	A B C	....	h12 in. h10 in. h8 in.	12 in. 10 in. 8 in.	....	....	h12 in. h10 in. h8 in.	12 in. 10 in. 8 in.	....
Denver & Rio Grande	A B C D	....	12 in. 10 in. 8 in. 6 in.	....	....	....	12 in. 10 in. 8 in. 6 in.	....	....
New York, New Haven & Hartford		9 in.	7 in.	7 in.	7 in.	k8 & 10 in.	9½ in.	9½ in.	9½ in.
Pennsylvania		6 in.	6 in.	6 in.	....	7 in.	7 in.	7 in.	....
Rock Island Lines	A B C	m6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	n6 to 10 in. 6 to 10 in. 6 to 10 in.	m6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	n6 to 10 in. 6 to 10 in. 6 to 10 in.
St. Louis Southwestern	*	12 in.	12 in.	12 in.	12 in.	13 in.	13 in.	13 in.	13 in.
St. Louis & San Francisco	A B C	o6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	p6 to 10 in. 6 to 10 in. 6 to 10 in.	o6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	6 to 10 in. 6 to 10 in. 6 to 10 in.	p6 to 10 in. 6 to 10 in. 6 to 10 in.
Texas & Pacific	*	8 in.	8 in.	8 in.	....	9 in.	9 in.	8 in.	....
Wabash	A	r8 in. r12 in.	....	....	....	r12 in. r8 in.	....	....	....

of stone ballast than gravel ballast. (This is probably largely affected by the high cost of stone.)

Number and Size of Ties per Rail Length.—The number of ties per rail length, where the roadbed is soft, materially affects the depth of ballast, for the fewer the ties the greater the weight on each tie, and a greater depth of ballast will be required to distribute the load more uniformly over the subgrade.

Stiffness of the Rail.—The stiffness of the rail materially affects the depth of ballast, for with the stiffer rail the wheel load is distributed over a greater number of ties and therefore the load on each tie is reduced. The unit weight being less, it is not necessary to distribute same as uniformly on the subgrade.

Weight and Number of Wheel Loads.—The greater the weight and number of wheel loads the greater the necessity for increased depth of ballast, so as to distribute the weight on the subgrade as uniformly as possible.

Cost of Material Used to Construct the Track.—From an economic standpoint the proper depth of ballast frequently depends on the cost of the various materials of which the track is constructed; for example, where ballast is very expensive it may be advisable to increase the weight of rail and cut down the depth of ballast.

Dimensions of Ballast Section.—As information a statement is given showing the dimensions of the ballast sections on various railways.

CONCLUSION.

On account of the complicated conditions which govern the proper depth of ballast, the sub-committee feels unwilling to recommend any definite rule for the proper depth of ballast, but offer the above information as a guide to determine the proper depth of ballast where the local conditions are known.

Sub-committee B submitted no report.

Sub-committee D did considerable work upon the subject assigned to it and submitted a report to the general committee, but as the committee deemed it advisable to consider the subject of gravel ballast further before adopting the report, it was referred back for further investigation.

The committee asks that the recommendations contained in the report on the Revision of Manual be adopted.

The committee requests that the other matters assigned to it be referred back for further consideration. Some, if not all, of the members feel that there is much valuable information to be gained by further investigation of the subject of proper thickness of ballast; that independent investigations, with possibly some instrument designed for the purpose of measuring actual pressure transmitted by ballast, can be made with profit.

The report is signed by: John V. Hanna (K. C. Term.), chairman; C. A. Paquette (C. C. C. & St. L.), vice-chairman; F. J. Bachelder (B. & O.); W. J. Bergen (N. Y. C. & St. L.); C. T. Brimson (Q. O. & K. C.); C. B. Brown, Jr. (C. P.); J. M. Egan (I. C.); H. E. Hale (M. P.); G. D. Hicks (N. & St. L. R.); C. C. Hill (M. C.); J. S. Lemond (Southern); J. M. Meade (A. T. & S. F.); C. S. Millard (C. C. C. & St. L.); F. J. Stimson (G. R. & I.); S. N. Williams (Cornell College).

Discussion on Ballast.

The sub-committee on gravel ballast secured at a late hour the results of some extensive experiments, which have been made in Germany, on the proper thickness of gravel ballast, but the translation of the article which gave the results of these experiments was not obtained in time to present as part of the proceedings. We expect to use this at a later date, in connection with the work of this committee. There was a joint meeting of the committees on roadbed and ballast on Monday, at which the committees considered the question of the range of the unit pressure on top of subgrade or bottom of ballast. The sub-committee recommended that the article on "Gravel as Ballast," by C. Brauning, published in the Zeitschrift fur Bauwesen, Vol. LIV, 1904, which Mr. Dawley has translated, be published in the proceedings of the association.

Hunter McDonald: (N. C. & St. L.) Referring to the report of sub-committee A, I see no reason for the insertion of the clause, "it shall be free from dirt, dust or rubbish," especially with regard to dust. Dust will certainly pass through a ¾-in. screen. I think that clause should be amended that it shall be free from foreign matter.

C. A. Morse: (A. T. & S. F.) You might have rock with dust in it that would go through a ¾-in. ring, but there are roads in the country that do not make a practice of screening their ballast. I think that clause would make it the sense of the association that ballast should be screened. Regarding the size of the large ring, I would rather have it 2¾-in. than 2½. I do not think 2½-in. represents the practice at this time.

Mr. Williams: The committee made a very thorough investigation a year ago, to obtain the results of the practice from about 37 different railways throughout the country, and we found that about one-half gave the maximum as stated.

J. M. Mead: (A. T. & S. F.) As one of the members of that committee, I argued against that large-sized stone. It is almost impossible for the section men to surface the track or even smooth it up with 2½-in. rock, and it was my judgment that that size should not be recommended. I would favor changing it to 1½-in., or even smaller.

Mr. McDonald: Does not the manual now provide for sizes of 2½-in. and ¾-in.?

The President: The manual says at present: "The maximum size of ballast shall not exceed pieces which will pass through a screen having 2-in. holes."

Mr. Mead: At the last convention the association approved the 2½-in. stone, but that action was not printed in the manual.

The President: The manual has not been reissued. This is an opportune time to make any change so that it may be incorporated in the new manual.

Mr. McDonald: I move that the wording of the clause regarding the size of the stone, as presented by the committee, be retained, with the exception that the dimension of 2 in. be restored, as it formerly appeared in the manual.

Mr. Morse: I would amend that to reduce the lowest size to ⅝ in., making it 2 in. for the maximum and ⅝ for the minimum.

Mr. McDonald: I think that one of the principal matters to be considered in the purchase of ballast is the question of commercial sizes, and if you get the size down so small as that, you will render the amount of screenings derived from it so small that there will be very little money in getting out the ballast. I prefer to retain the sizes as 2 in. and ¾ in.

Prof. Williams: The committee would like to have an expression of the members on this point.

W. H. Courtenay (L. & N.): I express the opinion that the 2½ in., as specified by the committee, should remain.

M. L. Byers: (Mo. Pac.) I think you can separate the stone-ballasted track into two classes, the first being the track for passenger service. In that case you want a clean ballast, the ballast that will give you the minimum amount of dust. There is a great deal of track to which that argument does not apply with any very great force. There is much track in which you are not particularly interested in securing freedom from dust, but you are interested in maintaining the permanence of the position of your track. We have been obliged to do considerable reballasting work on a lot of track which was evidently ballasted with broken stone. I think the specification as to the upper limit probably was that the stone must go between the ties. Now, in that condition, the track is very hard to maintain, and it is hard to get any accurate surface on the track, and yet by filling that track in with smaller material and raising it sufficiently to put the coarse rock down below the bottom of the tie, we have practically formed a macadam surface, in which the ballast below the bottom of the tie has become practically a solid mass, and above the bottom of the tie, and, perhaps, for an inch below the bottom, we have a fine material, which can be cheaply worked. I think it is fairly well known that a man can put in a great many more ties per day in gravel ballast than in sand ballast, the reason being he has a finer material to work with. For track in a soft subgrade, there is no very material necessity for 2½-in. upper limit. Our experience shows that we can use 6-in. stone to very good advantage, provided there is mixed with that 6-in. stone a finer material, just the same as is used in building a macadam highway. That distributes the pressure from the tie to the subgrade to good advantage, and that is one of the principal objects of using the ballast. So I am inclined to think that in our discussion we should keep clearly in view the two requirements: first, the stone ballast for important passenger line, where it is desirable to eliminate dust, and second, where we simply wish to have ballast for the purpose of distributing the pressure from the tie to the subgrade and consequently we want as solid a combined material as we can get.

Prof. Williams: In our investigations we found that the Pennsylvania Lines, the B. & O. and some other roads are using large sizes up to 3 in., and that the lines of great passenger traffic are favoring the larger rock, 2½ and 3 in., and so we did the best we could, and made it 2½ in., instead of 3 in.

Mr. Morse: If we could have ideal conditions, there is

no question we could go from 2½ to 4 in. ballast, but it has not been found practicable to handle it. In the last lift, it is desirable to use fine ballast. As a rule, the larger the ballast used, when the road is first ballasted, the larger the subsequent ballast must be. When you get 2½-in. stone to surface on, you must make a 2½-in or 3-in. lift every time you want to resurface.

Mr. Byers: I think that difficulty can be practically avoided by unloading the ballast in two different unloadings. It means unloading enough ballast to raise the track up to within practically an inch of the final grade, then following that with finer material, unloaded from a center dump, Rodger ballast car, and finishing the raising and ballasting of the tracks with that finer material.

C. E. Lindsay: (N. Y. C. & H. R.) In specifying the maximum size of ballast you add to the cost. The stone that is larger than 2½ in. has to be re-elevated, and again passed through a crusher with additionel waste, and therefore the manufacturer seeks a larger compensation. It would be interesting if the committee would decide what proportion of a given quantity of ballast should be of the different sizes, varying by half inches; how much 2½-in. stone, how much 2-in., how much 1½-in., and now much 1-in. Our stone is not all 2½-in. stone, nor all ¾-in. stone. It is a mixture depending on the sizes and character of fracture of the rock. In my experience with limestone and flat rock, we do not find, with 2½-in. stone, there is any difficulty in keeping the track in first-class alignment.

C. H. Stein: (C. of N. J.) I note the committee says: "Of such size that they will, in any position, pass through a 2½-in. ring," I believe it would be very hard for the rock quarries to produce such stone as would in any position pass through a 2½-in. ring. According to the fracture of the rock, a great deal of it is somewhat slabby, and, while it may have a thickness and breadth of 2 in., it may be 3 or 4 inches long, and you would find a large proportion of the ballast that would not pass through a 2½-in. ring in any position, although it would make good ballast.

Mr. Begien: It should be clearly understood that it is not necessary in the use of 2½-in. ballast to use all 2½-in. stone to raise the track. The section foreman in cleaning out would select a smaller size stone to make a ¼ or ½ in. raise.

W. J. Bergen: (N. Y. C. & St. L.) It is clearly the intention of the present recommendation to eliminate those long pieces. If you specify 2½-in. ring, without saying, "in any possible direction," you are likely to get long, scaly pieces, which will powder and will not make good ballast.

Mr. Osgood: I have very strong doubts whether the 2½-in. stone, which is frequently used for ballast, ever meets this requirement without being much smaller than what we are accustomed to call 2½-in. stone. The difficulty is that in screening the stone, it passes through a screen which has holes of the desired size. There is no possible way of getting the stones so arranged that you will have them in every direction. If you are going to enforce this specification literally, you will not have a 2½-in. stone, but nearer a 1½-in. stone.

Mr. Moss: I move that we change the lower limit to ⅝-in. diameter.

Mr. Stimson: I think it would be a mistake to lower it below ¾ in. We have found that for trap rock and granite ¾-in. is a good minimum size, but for limestone and soft stones, that break up easily, 1 in. gives the best results.

C. C. Cook: (B. & O.) If the minimum size is too small, a great deal of the fine stone will pass through the fork, in cleaning, and it will be loaded with the dirt thrown down the bank. A great deal of ballast is bought by weight. We pay as much for the fine stone as for the large, and we get the use of the stone for two to five years, and it is thrown away.

Mr. Kittredge: A ⅝-in. ring would be all right for trap rock, and very hard stones, but for the majority of cases I think ¾ in. should stand. There are many limestones that are good in the ¾-in. size, which would not be in the smaller size. They would pulverize and become dusty.

Mr. McDonald: I make the point that it was disposed of last year, and we are already on record as having adopted the 2½ in. and ¾ in. sizes, and I don't understand that the committee intended any change at this time in that recommendation, but simply to change the wording of the resolution, how it should appear in the manual. Now to reopen the question of size, I think, before this house, while a discussion is all right, would not be profitable, and if we wish further action we should instruct the committee to further consider it, and not reverse ourselves in this meeting.

The President: Of course the Chair must entertain any motion made by a member to change any previous action of the association. As I understand, the motion is to change the minimum size from that now adopted, to another size.

The motion to change the lower limit from ¾ in. to ⅝ in. was voted upon and was lost.

Mr. McDonald: The words "dust, dirt and rubbish" should be stricken out, and the words "foreign matter" be substituted.

After a short discussion on the wording of the report, the recommendations of the committee were adopted.

ECONOMICS OF RAILWAY LOCATION.

The following work was outlined:

(1) Consider revision of Manual.

(2) Continue the consideration of all questions connected with railway location, grades, lines, and improvement of grades and lines affecting the economic operation with relation to traffic, tonnage, ratings, speed, density of traffic and financial considerations, with the special aim in view of establishing uniform methods and unit values for investigating and analyzing the relative changes and costs of comparative routes or proposed grade reductions and line corrections.

(3) Make concise recommendations for next year's work.

Realizing that authentic data with reference to operation of railways was necessary in order to proceed much further with the work as outlined, and knowing the nature of the "walls" with which the railway companies surround their statistics, the chairman of the committee wrote to the secretary on April 6, 1910, suggesting that if the directors and officers of the association, as well as such committee members as could do so, would furnish from their own roads the data required, it would give the committee substantial material to work on. The committee would hold all such information confidential, and in their reports would refer to the roads either by some designating number or letter. The following information was desired: (1) A statement of the percentage to nearest one-hundredth per cent. that each of the primary accounts bears to the total operating expenses, based on the Interstate Commerce Commission's classification of June, 1907. (It is desirable to have this cover a two-year period if possible.) It is particularly essential that the following accounts be subdivided, if possible, in order to make a proper analysis: "Other track material;" "railway and track;" "bridges, trestles and culverts;" "buildings, fixtures and grounds;" and where possible it is particularly desirable that the following be divided between passenger and freight service: "Station employees;" "road enginemen;" "fuel for road locomotives;" "road trainmen;" "train supplies and expenses." (2) Operating expense per freight train mile. Operating expense per passenger train mile. (3) Trains per annum per mile of road; freight; passenger. (4) Approximate average running speed; freight; passenger. (5) Approximate tons train, including equipment; freight; passenger. (6) Number cars per train; freight; passenger. (7) Number pounds coal per train mile; freight; passenger. If fuel oil is used, the quantity per train mile for each class service should be given. The (2) to (7) data should be given for each class of track covered by reports received under clause (1). The committee also needs further information with reference to relative wear of rail on curves, compared to wear on tangent under same traffic conditions. This is essential as one of the elements entering into the value of curvature.

On September 19, 1910, the president sent a letter to each member of the board of direction, requesting that they furnish the desired information. Four replies have been received to the president's letter up to December 13, 1910. Other members of the board may be compiling the information requested. It is certain that nothing of real value can be done by this committee if they are not furnished with sufficient information on which to base conclusions. The work of this committee is vitally connected with the economic operation of railways, and its work must cease if the railways represented in this association cannot furnish the required statistics. Neither can the railways expect members of this committee to devote hundreds of dollars' worth of time to the work if the roads take the position that they do not care to assume the expense of gathering the information. The chairman and some of the members are making such investigation as they may have time for, along the lines of the committee's work, but these are individual studies which cannot extend beyond the narrow field of statistics immediately available. The chairman recommends that the committee be discharged from further study of the question, unless the board considers the

work of sufficient importance to furnish such information as may be required from time to time.

The report is signed by A. A. Shurtleff, chairman.

R. N. Begien: I am sorry Mr. Shurtleff is not here to make a statement to the convention with regard to the failure of the various railways to furnish data for the committee to work on. Up to the present time I believe answers have been received from about seven railways, those being the ones represented by the members of the board of direction. The sub-committee, which had in charge the subject of tonnage rating with respect to economical operation, has conducted certain tests on the Baltimore & Ohio this year to determine train resistance. In order to make those tests final, and as conclusive as possible, engineering corps were organized to run the profiles of the various divisions, which we were to examine. We made, first, tests of passenger trains. There were fourteen runs, aggregating four thousand miles. Then there were 12 runs made of fast freights, with an idea of examining particularly speeds between 20 and 50 miles an hour of freight trains, and after that, about 6,000 miles of slow freight runs were made. We were able to examine the resistance on two divisions only, owing to the time between the finishing of the runs and the time of this convention. On these runs we took observations for coal consumption, water, steam, the train line, position of the reverse bar, and the throttle, and in examining the water consumption, both the calibration of the tank was made and the number of minutes that the injector was in service. We have all of the material for making a very complete report, but it will take considerable time to do it. A year ago the committee reported that on slow freight work but little change of resistance was noted between 5 and 35 miles per hour. After examining the work on our Newark division, between those same speeds, I believe that we are justified in still making that contention. There have been some experiments made during the year which would not seem to bear out that contention, but I believe that on mixed trains containing cars of various weights, it can be safely said that for all practical purposes, there is little change in resistance between 5 and 35 miles per hour. Another point of interest was noted in connection with temperatures. One train was taken out of our yard at Newkirk, Ohio, which had been standing all night. It took two engines to get it out of the yard, although the grade was slightly below the ruling grade. For nearly two hours after the train had started it was noticed that the resistance was high. On leaving the yard the train resistance was about 20 pounds to the ton, and stayed up to that point for half an hour, and it was not until the train went over the summit nearly two hours later, that the normal resistance began to be noted, which averaged very close to what was established in the formula adopted by this convention last year. In fact, I might say that up to date the net results of the experiments have been that the formula published in the proceedings last year, appears to be a fairly good formula for practical use.

The President: The board of direction has given careful thought and attention to this committee, and there is one recommendation which the chairman of the committee made, which the board of direction and the association is not ready to adopt, and that is that this committee be discharged from further study of the question. The members of the board of direction, at least, expect to make every possible effort to furnish information to this committee. Mr. Shurtleff has given a lot of his valuable time, energy and skill to this work, and we are not ready to accept his resignation. I think the association should give this committee all the assistance and support possible in the way of information, because without information this committee cannot carry on its work.

Mr. Kittredge: I want to say possibly in justification of those who have not given the committee the data they desire, that there is really very little information available in actual figures and tests. We all know and appreciate the advantages derived from economic location and changing grades, but very few of us have any figures that we can put into print, showing the actual economics that have been accomplished by changing grades. I appreciate the position of the committee, and yet I do not think it is putting the roads that have not furnished the information quite in the proper light to leave the impression that they have been negligent. We have not been negligent; we have been unable to give it in the way it is wanted.

Mr. Thompson: (B. &. O.): The results of the dynamometer tests which Mr. Begien has mentioned, will be platted up, and the full result and report will be gotten up by the B. &. O., and given to the committee. With due respect to the remarks of Mr. Kittredge, I think some of the roads have not felt the importance of the committee's work, and they probably thought that they did not have any data on this subject. I believe that if each railway would at least recognize the committee's letters, the committee would go farther than they have gone in making an intelligent report. To show the value of one point that Mr. Begien makes, of the resistance of trains out of yards, we are spending on two new yards that we are completing, an additional amount of about $60,000 to reduce the grade out of the yards to give the trains a chance to get out promptly. That point demonstrates how slowly trains move out of the departure yards.

TIES.

Sub-committees were appointed as follows:

Revision of the Manual: E. E. Hart, chairman; W. F. H. Finke, G. W. Merrell.

Statistics: L. A. Downs, chairman; F. G. Jonah, Edward Lass.

Metal, Composite and Concrete Ties: W. F. H. Finke, chairman; H. S. Wilgus, E. D. Jackson, F. R. Layng.

Use of Cypress as Tie Timber: F. G. Jonah, chairman; A. F. Dorley, H. C. Landon.

The sub-committee on revision of the Manual has no recommendation to make for changes in the present version.

Under Appendix A will be found the report of the sub-committee on cross-tie statistics.

Supplementing its previous reports on the subject of metal, composite and concrete ties, this sub-committee presented a progress report. A circular letter was sent to the roads using the various metal and composite ties, and their replies indicate that there has been little change in the condition of these ties from that reported last year, and that these ties are still generally giving satisfactory service. No new type of practical design has been patented or installed.

As opportunity has offered, the sub-committee has examined ties removed from track by sectionmen in the regular work of renewals, and measurements to determine depth of cut were made by means of a straight edge and a wedge-shaped graduated gage. It was found that where ties are not protected by tie-plates the cutting or abrasion of the ties by the rails and the outward tilting of the rails is marked on tangents as well as curves, and adzing of the ties at intervals is necessary on both curves and tangents to maintain the rails in position, perpendicular to the plane of the tie. The measurements taken show the maximum cutting of the ties, as all ties examined had been removed from track. From observations and from information obtained, the sub-committee is of the opinion that flanged tie-plates of suitable width and thickness and properly applied on tangents as well as on curved track will lengthen the life of cross-ties from one to two and in some cases three years, and in the meantime the track will have been maintained in better gage, line and surface, and at less cost, than the same track could have been without tie-plates.

CONCLUSION.

The committee presents this report as a report of progress. The report is signed by: E. E. Hart (N. Y. C. & St. L.), chairman; W. F. H. Finke (Southern Ry.), vice-chairman; A. F. Dorley (M. P.); L. A. Downs (I. C.); W. F. Goltra, Cleveland, Ohio; E. D. Jackson (B. & O.); F. G. Jonah (St. L. & S. F.); H. C. Landon (Erie); Edward Laas, Los Angeles, Cal.; F. R. Layng (B. & L. E.); G. W. Merrell (N. & W.); L. M. Perkins (N. P.); H. S. Wilgus (P. S. & N.).

APPENDIX A.

Statistics of Cross-Ties.

The sub-committee issued the following circular of inquiry:

"In endeavoring to collect data relative to statistics of cross-ties, the Committee on Ties has concluded that few railroad companies, if any, have complete or reliable information concerning the life of ties. Most railroad companies have good records of renewals of cross-ties each year, and, in many cases, keep such records by miles.

"It is believed that the approximate life of ties can be arrived at in the case of new track, built within the last ten or fifteen years, the number of ties originally placed in the track being known and also the total number in the whole length of track and the number taken out of track each year.

"During the past ten years you have probably built extensions of some kind, or built new second track, or had grade reduction work where certain kinds of ties,

either treated or untreated, have been put in out of face. It is immaterial if the track is one mile or 200 miles in length. Information of this character is what the committee desires.

"Enclosed herewith is a blank form which can easily be filled out during the year the ties were laid, the number removed each year to date and the kind of ties used, whether treated or untreated.

"Date constructed; between what two cities or towns; state; length of track in miles; number of ties per mile; total number of ties; kind of ties; number of ties used in renewals, according to years, as follows: 1895, 1896, 1897, 1898, 1899, 1900, 1901, 1902, 1903, 1904, 1905, 1906, 1907, 1908, 1909, 1910."

The replies received in answer to this circular have been tabulated and are given in Table 1.

APPENDIX C.

The Use of Cypress as Tie Timber.

The increasing use of cypress as a tie timber has led the committee to make some investigations concerning same, and accordingly a postcard inquiry was sent out to proper officers of all the roads operating in the South Atlantic and Gulf states, where cypress ties are most generally used. The following questions were asked: Number of Cypress ties in track; Dimensions; Kind of Cypress; Red, White, Yellow; Pecky, Clear; Average life; Remarks.

Replies were received from a great many roads giving the information wanted. Several roads replied that they had many cypress ties in track, but had no accurate record, and consequently gave no figures, while a number made no reply. The information obtained is tabulated and published in the appended table.

Discussion on Ties.

Mr. Wendt: I promised the committee to give them some data on the cost of labor in connection with the two experimental sections of track on the Pittsburgh & Lake Erie. This track was originally laid in 1907 and was not resurfaced for fifteen months. In the fall of 1908 both sec-

DATA RELATING TO CYPRESS TIES.

Name of Road	Official Reporting	No. of Ties in Track	Dimensions	Kind of Cypress	Clear or Pecky	Average Life in Track	Remarks
Central of Georgia	C. A. Lawrence, Chief Engr.	1,334,739	7x8x9	Red and black		No accurate date; 10 to 12 years when protected with tie plate.	The number given is the number of red and black cypress ties that have been put in track since 1900, averaging 133,474 per year.
Charlotte & Western Carolina R. R.	A. H. Porter, Engr. R'dway.	440,000	7x9x8½	Red and black		12 to 14 years	White and yellow cypress not used in this section. Will not last more than 2 or 3 years. Tie plates required where traffic is heavy and on curves.
Chicago, Rock Island & Pacific	J. B. Berry, Chief Engr.	None					Think of trying some pecky cypress in Louisiana.
Cleveland, Cincinnati, Chicago & St. Louis R. R.	C. S. Millard, Engr. Track & Roadway	2,200					1,000 on Cairo Division, 1,200 on Vincennes Division in Illinois, been in about 7 years, are in fair condition.
Florida Central Ry	J. H. Davidson, Gen. Supt.	None					We will use red and black cypress after this year.
Florida Railway Georgia & Florida	W. A. Swallow, Ch. Engr. Superintendent,	10,000 20,000		Red Red and white	Clear		O. K. with tie plates. Practically all ties new within last 2 years.
Georgia Coast & Piedmont	T. S. Williams, Roadmaster	50,000	6x8 to 7x10	Red and white All classes			
Georgia Railroad	W. M. Robinson, Roadmaster	30,000	7x8x9	Red, black and yellow	Pecky		Have been in use about 4 years. As cross-tie timber white cypress is of little value.
Illinois Central	A. S. Baldwin, Chief Engr.	2,000,000	6x8x8 7x9x9	Red, black and yellow	Some pecky mostly clear		We find the average of white or yellow cypress ties, if ¾ sap, 2 to 3 years; if all heart, 8 to 12 years; red, 12 to 15 years.
International & Great Northern	O. H. Crittenden, Chief Engr.	200,000	6x8x8	Red and yellow	20% pecky 80% clear	12 years	More than ¾ wear out, life of other ¼ about 12 years.
Louisiana Railway & Navigation Co.	C. R. Mee, Roadmaster	95% of 333 miles	6x8x8 7x9x9	Red		Red, 11 years; yellow and white heart, 8 years.	Cypress is the tie for this climate.
Louisville & Nashville	W. H. Courtenay, Chief Engr.	1,397,915	7x9x9	Red, white and yellow			All laid on divisions south of Montgomery.
Missouri Pacific Railway	M. L. Byers, Chief Engr. M. of W.	100,000	6x8x8	Red and white	Both		Would not recommend using cypress ties unless I could get all heart.
Mobile & Ohio	B. A. Wood, Chief Engr. of Maint.	10,000	7x9x8.5	Red and white	Both		Red and yellow cypress ties are the best, from 2 to 4 years longer than white oak under similar conditions.
Norfolk & Western	C. S. Churchill, Chief Engr.						Up to 1890 this road used large numbers of cypress ties, secured along its line in eastern part of Virginia. We found their life to be from 12 to 14 years. The demand for cypress for shingles, etc., became so great, no longer put on market for cross-ties. We ceased buying cypress for ties in early nineties. Last few years have been using red cypress ties in track in tunnels.
St. Louis & San Francisco	M. C. Byers, Chief Engr. Operation	175,000	6x7x8 6x8x8 6x8x9 7x10x8			10 to 15 years for red and yellow	50,000 red cypress treated ties in Oklahoma, 115,000 red cypress untreated ties S. E. Mo. and N. E. Arkansas. Will outlast oak. White cypress not good. Pecky cypress will last long time but will not hold spikes.

tions were resurfaced, the cost of labor being the cost of track labor.

Three thousand steel cross ties, Carnegie design, with clip and bolt rail fastenings, were placed in northward freight track, McKees Rocks, Pa., in September, 1907, by the Pittsburgh & Lake Erie. These steel ties are laid in a stretch of track 4,400 ft. long. The succeeding 4,400 lineal ft. of the same northward freight track was laid at the same time with new No. 1 white oak ties. New steel rails, 90 lbs. A. S. C. E. section, were laid on these ties, and new limestone ballast was used throughout the entire length of 8,800 ft. of track. The track was originally surfaced in September, 1907, the depth of ballast being about 8 in. Since that time a careful record of all labor expenses in connection with the maintenance of both steel and wooden tie sections of experimental track has been kept. After being originally built and ballasted, these two sections of track were not surfaced a second time for a period of about fifteen months. In November, 1908, both sections were resurfaced, the cost of labor being: Cost of track labor per mile per year where wooden ties are used, $417; cost of track labor per mile per year where steel ties are used, $280. During the following 12 months these two pieces of track were simply patrolled, no labor being expended on either line of surface. In November, 1909, both stretches of track were resurfaced with the following result: Cost of track labor per mile per year where wooden ties are used, $95; cost of track labor per mile per year where steel ties are used, $153. During the succeeding 12 months the track with steel cross ties was resurfaced three times, while the track with wooden ties was resurfaced once, with the following result: Cost of track labor per mile per year where wooden ties are used, $128; cost of track labor per mile per year where steel ties are used, $428. These experimental sections being part of the northward freight track in the four-track system, electric circuits in connection with automatic signals are in use, and it is interesting to know that during the 42 months in which these steel ties have been in use the fiber insulations have given no special signal trouble. The track at the present time is in good line and surface, and while all bolts and clip fastenings on the steel ties are tight, it is a fact that the fiber insulations are considerably worn, and this condition permits the rail to creep in the direction of traffic, which results in the ties being slued. The drainage of this track is good. During 1909, 20 broken angle bars were removed from steel tie joints. During 1910, 18 broken angle bars were removed from steel tie joints. The speed of freight trains at McKees Rocks, where this track is located, averages about 30 miles per hour.

These figures simply represent the annual results in connection with an experiment which has now been in progress three and one-half years. The data is interesting but is not conclusive, for the reason that the relation of the expense in connection with a wooden tie track and a steel tie track varies. In the early days of the experiment, one

DATA RELATING TO CYPRESS TIES—*Continued.*

Name of Road	Official Reporting	No. of Ties in Track	Dimensions	Kind of Cypress	Clear or Pecky	Average Life in Track	Remarks
St. Louis, Brownsville & Mexico	E. C. Burgess, Engr. M. of W.	207,775		Red, white and yellow	Both		
Seaboard Air Line	J. C. Nelson, Engr. Maintenance of Way	2,000,000	7x9x9	Red and black	Both		If you are gathering data to get up specifications, I would suggest that you omit the names of different kinds of cypress and simply specify heart cypress. My experience has been that the names are simply local, and that what is known as yellow and red, etc., in one state, may be entirely different in another, but the heart of any cypress in any state, no matter what its local name may be, is all right. On the other hand, cypress known as red, black or yellow is worthless, unless it has heart. We get cypress in North Carolina, South Carolina, Georgia, Florida, Alabama and some little in Eastern Virginia. Timbermen in some of these sections will tell you that yellow cypress is all right, and another will say that it is worthless, and after some years' experimenting and groping in the dark, I found that the name cuts no figure, and while along the line of our road we use the names red and black, it really means nothing and we are very careful to specify the heart dimensions.
Sunset Lines, Atlantic System	A. V. Kellogg, Engr. M. of W.	5,705,567	6x8x8 7x8x8 7x9x8 7x9x9 8x10x10	White	Clear		
Tampa & Jacksonville	F. C. Parrigin, Engineer	7,000	7x9x8.5	White	Clear		These ties have been put in, in last 24 months. Indications are they will last about 4 years.
Texas & Pacific Ry	B. S. Wathen, Chief Engr.	2,633,664	7x9x9 6x8x8	Yellow, red and black	Clear		We have not had any cross-ties of this class in use longer than 7 years; believe 10 years about the average life.
Vicksburg, Shreveport & Pacific New Orleans & Northeastern	E. Ford, Asst. to Prest.	175 miles 46,000	7x9x9 7x9x9	Red and yellow Red and yellow	Both	12 years	V. S. & P. Delta Point to Shreveport; 175 miles laid with cypress ties, 2,816 to the mile, only receive red or yellow cypress. Do not object to pecky ties if they are not so pecky as to prevent holding spikes; yellow cypress ties do not last as long as red cypress ties but last considerably longer than pine or oak ties. V. S. & P. has no curvature exceeding one degree; have but little trouble with cypress ties on curves. The crossties on the N. O. & N. E. would get too soft and have to be taken out from mechanical wear instead of from decay. Cypress ties on N. O. & N. E. are of poor quality and will not last as long as ordinary pine ties.

Total No. of Ties in Track, 17,780,075.

TABLE 1—STATISTICS OF CROSS-TIES. TABLE 1—CONTINUED—STATISTICS OF CROSS-TIES.

Railroad	Kind of Ties	Number	State	Year Laid	NUMBER OF TIES REPLACED FOR THE YEARS															
					1895	1896	1897	1898	1899	1900	1901	1902	1903	1904	1905	1906	1907	1908	1909	1910
A. T. & S. F. Ry., Olinda Dist.	Burnettized Arizona Pine	11,827	California	1899										1,014	996	1,096	3,202	2,077	2,411	780
B. & O. R. R.	Oak	201,600	Ohio	1899–1900										3,864	4,276	12,173	22,034	27,671	34,697	
Canadian Pacific R. R.	Tamarack	432,810	Saskatchewan	1891			865	2,160	4,320	22,000	41,488	60,936	64,394	59,072	64,825	53,156	37,167	87,086	67,086	
Central Railroad of N. J.	Oak, Yellow Pine, Chestnut	1,237,653	N. J. and Penna.	Various						354,018	345,991	347,595	263,922	450,545	403,405	265,617	264,553	297,978	408,942	
C. B. & Q. R. R.	Treated Black Oak	40,885	Illinois	1904												17	478	178	761	323
C. B. & Q. R. R.	White Oak	179,534	Illinois	1905												41	105	1,641	1,556	5,256*
C. B. & Q. R. R.	White Oak and Cypress	242,328	Missouri	1903–1901												165	1,021	4,036	15,009	23,520*
C. B. & Q. R. R.	Tamarack, Cedar, Pine	329,774	Nebraska	1905–1906													2,820	33,414	3,225	17,673†
C. B. & Q. R. R.	Treated Pine and Fir	313,808	Wyoming	1906														2,986	586	1,968†
C. B. & Q. R. R.	Treated Pine, Fir, Untreated Pine, Fir, Cedar	480,300	Wyoming and Montana	1901														9,649	21,607	18,502†
Chicago, Indiana & Southern	Red and White Oak	55,500	Illinois	1899												13,011	6,971	5,088	5,585	
C. M. & St. P	Yellow Pine	7,500	Iowa	1900												695	695	695	695	345
C. R. I. & P	White Oak	101,700	Texas	1903													27,608	38,424	22,162	5,782
C. R. I. & P	Cypress, Gum, W. Oak, Pine	175,500	Louisiana	1907															19,108	12,431
C. R. I. & P	White Oak	318,100	Arkansas	1906–1907													12	3,306	17,367	19,350
C. R. I. & P	White Oak	137,200	Arkansas	1907														640	5,218	5,254
Duluth & Iron Range	Tamarack	7,500	Minnesota	1902														460	2,420	2,630
Erie Railroad	Oak	8,605	Ohio	1903												515	1,899	250	1,023	265
Ft. Smith & Western	Oak, Yellow Pine	694,300	Oklahoma	1901–1902												26,090	59,768	116,400	78,655	
Ft. Worth & Denver City	Pine	1,433,248	Texas					156,455	149,989	202,075	231,320	100,656	213,808	200,236	130,717	159,432	314,128	318,948	308,907	120,365
Grand Rapids & Indiana	Oak, Cedar	11,117	Michigan	1898														1,750	1,700	600
Grand Trunk System	Cedar	83,200	Canada	1900														800	1,760	2,500
Hocking Valley	White and Mixed Oak	1,075,700	Ohio	1874–76–81	118,400	110,400	135,450	126,311		137,900	152,000	124,700	120,000	135,800	150,000	134,500	126,300	104,000	199,090	155,665
Illinois Central		10,607	Iowa										1,943		1,556	592	1,397	1,809	2,690	1,320
Illinois Central		9,828	Minnesota														632	1,375	4,350	3,469
Illinois Central	Chestnut	21,280	Kentucky	1905–1906														2,102	4,137	10,662
Illinois Central	Red Oak	51,200	Tennessee	1903														82	1,342	458
Illinois Central	Red Oak	22,400	Tennessee	1905														257	342	1,809
Illinois Central	Red Oak	28,400	Tennessee	1904														1,350	2,134	1,824
Illinois Central	Red Oak	48,000	Tennessee	1903														838	1,469	1,252
Illinois Central	White Oak	351,600	Iowa	1899							88	450	250	5,922	36,073	24,556	16,994	36,232	11,356	42,550
Lake Shore & Mich. Southern	White Oak	369,600	Indiana, Michigan, Ohio	1833–1862							38,196	39,676	33,620	31,495	28,724	33,473	47,253	40,650	64,789	38,000
Lake Superior & Ishpeming	White Oak	57,000	Michigan	1896									3,008	4,464	5,866	9,095	15,195	10,154	6,459	2,759
Louisiana & Arkansas	White and Post Oak	93,900	Louisiana	1903										80	55	65	2,524	12,152	23,628	18,450
Louisville & Nashville	White Oak	24,920	Kentucky	1895							1,200	5,649	3,652	1,487	3,628	3,873	4,825	3,821	2,112	2,479
Memphis, Helena & Louisiana	Cypress, Red and White Oak	236,160	Arkansas	1905												400	2,100	36,550	74,175	33,180
Missouri Pacific Ry																				
Missouri Pacific Ry	Oak	118,400	Louisiana and Arkansas	1906														3,145	6,725	20,378
St. L. I. M. & S	White Oak	342,400	Missouri and Arkansas	1905													510	5,384	24,058	39,810
Mobile & Ohio	Oak	646,631	Miss. and Alabama	1897						1,204	8,954	43,951	45,905	43,124	48,904	35,001	69,732	70,248	58,836	56,637
Mobile & Ohio	Pine	646,631	Miss. and Alabama	1897						6,341	12,521	48,131	60,989	54,408	50,092	26,843	24,148	21,649	45,446	14,126
Miss. River & Bonne Terre	White and Post Oak	9,758	Missouri	1902											181	354	233	328	1,532	479
N. Y. C. & H. R. R. R	Yellow Pine	14,688	New York	1903										300	400	200	100	200	100	500
N. Y. C. & H. R. R. R	White, Rock, Red Oak, Chestnut	150,048	Pennsylvania	1901–1902								2,086	9,201	11,696	15,292	15,296	34,342	30,688	23,686	10,007
P. & R	White Oak	16,915	Pennsylvania	1901												734	2,806	4,360	5,770	2,200
P. & R	Yellow Pine	21,805	Pennsylvania	1901													210	1,153	1,729	6,340
P. & R. (Little Schuylkill and Navigation)	Oak and Chestnut	5,760	Pennsylvania	1897											364	546	1,325	1,475	800	760
P. & R	Chestnut	2,816	Pennsylvania	1903															1,876	470
Penna. Lines West	White Oak	127,902	Ohio	1892				10,057	8,973	15,104	17,872	13,389	34,481	10,594	10,670	10,223	9,254	5,230	9,965	9,115
Pgh. Shawmut & Northern	White Oak, Yellow Pine	20,219	Pennsylvania	1902															234	569
Pgh. Shawmut & Northern	White Oak, Yellow Pine	22,256	Pennsylvania and N. Y.	1909																
Pgh. Shawmut & Northern	White Oak, Yellow Pine	65,725	New York	1902														81	95	953
Rutland Railroad	Cedar, Tamarack, Hemlock, Spruce and Pine	110,880	Vermont	1899–1900												5,785	21,506	16,256	10,393	7,647
Texas Midland	Oak	375,000	Texas	1882–1894 96				56,539	51,677	68,725	92,844	40,785	43,764	38,371	40,888	43,464	46,708	56,225	65,205	59,187
T. & N. O	Hemlock, Cedar and Tamarack	397,440	Ontario	1903–1904													3,390	10,123	35,192	60,925
Uintah Ry		153,000	Colorado	1904–1905												106	498	421	689	2,372
Washington Terminal	White Oak and Yellow Pine	137,000	District Columbia	1904–1906															1,194	3,213

* To August 1st.
† To August 1st. Records prior 1908 destroyed by fire.

character of track could be maintained with a less amount of labor, while in the latter experiment the situation was changed. It is not apparent at this time just what the results will be at the end of the fifth, seventh or tenth year.

RAIL.

The work outlined was as follows:

(1) Consider revision of Manual.

(2) Continue the investigation of the breakage and failure of rails and present summary of conclusions drawn from reports received.

(3) Report on the results obtained from the use of open-hearth and special alloy steel rails, and chemical composition of such rails.

(4) Present reports on the results of tests made in conjunction with the Manufacturers' Committee on the various kinds of rail, made by means of the special machines at the Pennsylvania Steel Company's mill and the Sparrows Point mill of the Maryland Steel Company.

(5) Report on any recommended changes in specifications for steel rails.

(6) Present recommendations on standard rail sections.

(7) Present report on rail joints, showing results of all tests at Watertown Arsenal, and recommend design and specifications.

(8) Reconsider and report any recommended change in standard drilling for rails, as given in the Manual.

(9) Make concise recommendations for next year's work.

REVISION OF MANUAL.

It is believed by the committee that the subject matter on Temperature Expansion for Laying Rails, 1907 edition, page 53, belongs to committee V, Track, and recommends that it be transferred to the chapter containing the recommendations of that committee.

In view of subsequent changes adopted, it is recommended that the Form for Reporting Rail Failures in Main Tracks, M. W. 1200, in the supplement to the Manual, bulletin No. 103, pp. 16 and 17, be withdrawn and replaced by Form M W. 404, Report of Rail Failures in Main Tracks.

The revision of this form was undertaken on account of the suggestion of C. E. Lindsay at the annual convention in March, 1910, that there ought to be a method for indicating the "Gage Side" of the rail, and this deficiency has been supplied by the addition to Question No. 39. At the same time, the numbering of questions was changed to eliminate the letters, and some of the questions were rearranged in what was thought to be a somewhat better order.

STATISTICS OF RAIL FAILURES.

While statistics of rail failures for the six months' period ending October 31, 1909, were published in bulletin No. 121 last year, data from a number of the roads was not received in time to be included. Therefore, the previous work in this bulletin has been included with the data since received in appendix B of this report.

This information is the most complete on the subject ever published. It has been stated by some that they do not believe these statistics furnish any information of value, but the committee believes that a careful study of the information will not warrant this conclusion. There are many hints to be derived from their study, and one of special importance is that differences in the production of ingots and the finished rail made from them may annihilate all advantages derived from any particular rail section. The design of rail section is not, therefore, the main cure for poor material.

EXPERIMENTS AND TESTS.

M. H. Wickhorst, the engineer of tests for the committee, has been conducting experiments and tests under the direction of the committee for the past year, and the results of his work are issued as appendix E of this report. In connection with the eleven separate reports made by Mr. Wickhorst, a statement of the results believed to have been accomplished by this work up to the present time is furnished.

SPECIFICATIONS.

Of course, the principal work of this committee is the preparation of a standard set of specifications for steel rail, and the large amount of data and statistics being published in these reports from time to time by the committee are to enable the members of the association, as well as the members of the committee, to determine upon a set of specifications which will bring about the manufacture of "good steel rails." The subject is a very intricate one and its study carries one back through all the processes of manufacture. It will, therefore, be readily seen that a large amount of time is required for this study, involving, as it does, the making of tests and the carrying on of experiments.

It is believed by the committee that no rails have as yet been purchased under the tentative specifications, but the differences between them and the specifications used by some of the large railroad systems are not very great. They are being brought nearer together all the time.

RAIL SECTIONS.

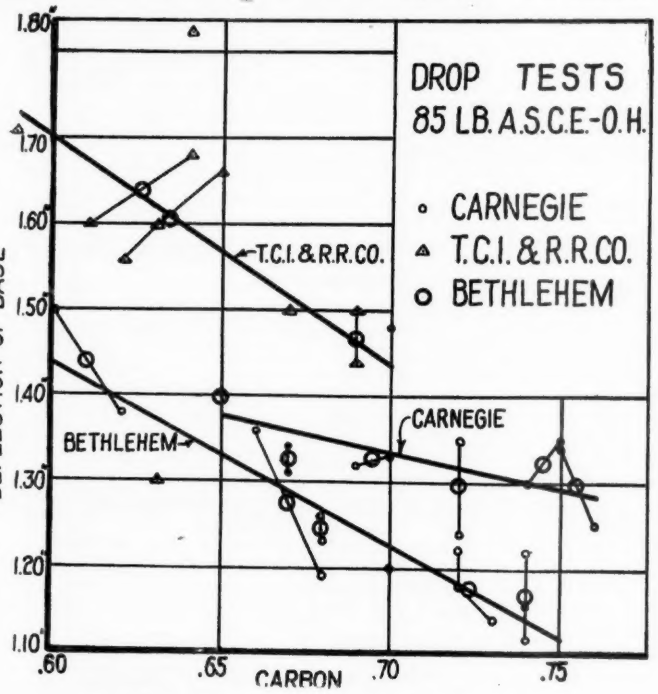
No attempt has as yet been made by the committee to design a new rail section, as many of the large systems have

begun to use the two types, A and B, designed by the American Railway Association, and it has been thought advisable to obtain information derived from service, relative to these sections and others of special design, which may be in use, before making any new recommendations. These new designs are being watched, and it is hoped that in the course of time some definite information will be obtained. At present there are two parties, one favoring type A, representative of the high stiff design with thin head, and the other type B, representative of the lower and more flexible design, with heavy head.

In order to throw some light on the controversy between those representing the thin head, on the one hand, and the heavy head, on the other, Mr. Wickhorst made his study on the "Strength of Rail Head," in his report No. 9 of appendix E. This study was intended also to give some information relative to the claim that the head of a rail is broken down by the excessive equipment loads of the present day, even though there be no physical defect in the interior of the rail head.

TESTS OF RAIL JOINTS.

The first series of these tests, made at the Watertown Arsenal, were published in bulletin No. 123, as appendix A, and are to be be regarded only as a progress report, as the entire series of tests have not been completed. Very guarded



Relation of Carbon Content to Deflection.

use should be made of the information in these tests, as the material in the different splice bars varies so widely that it is difficult to judge of the value of the different designs. The state of affairs is the same as in the case of the rail section, when the committee pointed out that all differences in rail section can be annihilated by the quality of the material.

STANDARD DRILLING FOR RAILS.

This study has been commenced, but has not yet proceeded far. Only progress, therefore, is reported.

MISCELLANEOUS.

Mr. Churchill has made a valuable study, involving the compilation of a large number of tests, which is included with this report as appendix C, Statement of Drop Tests and Chemical Analyses of Rails Rolled for the Norfolk & Western, giving results of various heights of drop on rails of known composition, and a comparison of rail analyses with mill analyses.

A tabulated statement of the different practices in connection with rail rolling in American mills has been compiled and is submitted herewith for the information of the members.

RECOMMENDATIONS FOR WORK IN 1911.

As nearly all of the different items of work of the rail committee are leading up to the preparation of a standard set of specifications for steel rail and the design of a standard rail section, together with the appliances that go with the rail, and as these specifications and designs have not yet been completed ,it is recommended that the outline for the committee's work during the coming year be the same as that for the past year.

Under item No. 4 the committee desires to make a closer study of ingot making, as the principal defects connected with rail manufacture seem to have their origin in the making of the ingot. It is true that the temperature of the bar during manufacture and the amount of work done upon it have a strong effect on the subsequent quality of the finished rail, but the studies of your committee lead it at present back to the ingot as the source of our most serious defects, viz: brittleness, unsoundness and segregation.

The committee also hopes to study the relationship of the chemistry to the deflection under the drop, for the purpose of making a deflection formula, and in this connection it may endeavor to establish a relationship between the tensile strength and the elongation, or between the permanent set, as given by the drop test, and the elongation, so that the ductility of the metal shall be valued in the acceptance or rejection of the material, by means of a co-efficient, as has already been done by Professors Tetmajer and Dormus. Work in this line has already been done for the New York Central Lines by Dr. P. H. Dudley, and his own statement of his practiice is submitted as appendix F.

CONCLUSIONS.

The committee presents the following conclusions:

1. That the subject matter on Temperature Expansion for Laying Rails, Manual, 1907 edition, page 55, be transferred to the chapter in the Manual containing the approved resolutions of committee V, on Track.

2. That the Form for Reporting Rail Failures in Main Tracks, M. W. 1200, be replaced in the Manual by Form M. W. 404, Report of Rail Failures in Main Tracks.

3. That the changes in Form M. W. 405 (old No. 2002-B) be approved, and the form included in the Manual.

4. That the drawing showing Standard Locations of Borings for Chemical Analyses and of Tensile Test Pieces be adopted and included in the Manual.

5. That the form for tabulating Results of Drop Tests and Surface Inspection of Rails be adopted and included in the Manual.

The report is signed by: Charles S. Churchill (N. & W.), chairman; R. Montfort (L. & N.), vice-chairman; Robert Trimble (Penna. Lines), E. B. Ashby (L. V.), J. A. Atwood (P. & L. E.), A. S. Baldwin (I. C.), J. B. Berry (C. R. I. & P.), M. L. Byers (M. P.), W. C. Cushing (Penna. Lines), F. A. Delano (Wabash), Dr. P. H. Dudley (N. Y. C.), C. H. Ewing (Atlantic City R. R.), John D. Isaacs (Harriman Lines), Thomas H. Johnson (Penna. Lines), Howard G. Kelley (G. T.), J. W. Kendrick (A. T. & S. F.), George W. Kittredge (N. Y. C.), D. W. Lum (Southern), Joseph T. Richards (Penna. R. R.), J. P. Snow (B. & M.), A. W. Thompson (B. & O.), M. H. Wickhorst, engineer of tests, rail committee.

APPENDIX B.

Rail Failure Statistics for Six Months' Period Ending October 31, 1909.

Statistics for this period were first published in bulletin No. 121, but, owing to the desire to have the report ready for the annual convention in March, 1910, the reports for a number of railways which were late in coming, were omitted. After the convention it was decided by the rail committee that it would be advisable to re-tabulate the information, using all the reports which had been received in answer to A. R. A. circular No. 966. The statistics are for the greater number of the larger railway systems, and the number of tons reported is 7,445,825.

In considering the number of failures, all lots less than 1,000 tons have been ignored, as they usually lead to exaggerated results. It should be borne in mind that these records are for six months only and in some cases the failures have not begun, while in others the poor rails have been pretty fairly weeded out.

Taking all the reports, the failures are divided into: broken head failures, web failures and base failures, according to the following percentages: Broken, 19 per cent.; head, 66½ per cent.; web, 8½ per cent.; base, 6 per cent.

The above are divided for the different weights of rail and between Bessemer and open-hearth steel as follows:

These figures do not show that the breakages of the heavy sections are fewer than the lighter sections, except in the case of 75-lb. rail. The head failures, however, of the 100-lb. rail seem to be materially less than those of 90-lb. and 85-lb. rail. With the Bessemer steel the head failures are the most numerous, those for the 90-lb. being slightly more numerous than for the others. Those for 85-lb. and 100-lb. rails come

next, and are nearly the same. The number of breakages is closely the same in all cases, while the web and base failures are quite insignificant. With the open-hearth steel the head failures of the 80-lb. rail are the most noted. In drawing comparisons between different sections of Bessemer rail, the head failures of P. S. 85-lb. rail are the most noticeable, amounting to 35.8 per 10,000 tons laid, but the explanation given is that they are principally from a lot of 2,045 tons on the Northwest system of the Pennsylvania Lines West of Pittsburg of Carnegie 1909 rails. During the month these rails were rolled many defective heats were found, indicating that the failures were caused by the quality of the material and not the rail section. Broken rails are comparatively few, the most noticeable being the C. S. 75-lb. and then the P. R. R. 100-lb.

In comparing the sections of open-hearth rail, the head failures are the most numerous in the A. S. C. E. 90-lb., G. N. 85-lb., C. S. 90-lb., and A. R. A.-B. 90-lb. There is considerable difference between the A. R. A.-A and the A. R. A.-B 90-lb., but it will be found that the greater number of failures come from Bethlehem, which simply happens to be in this case the A. R. A.-B section. The failures of the same section of rails from the Gary mills are much less in number. This last statement gives the clue to the real cause of the failures and further studying into these statistics will bring out this fact more strongly, viz: that the cause of failures is in the quality of the material and not the design of the rail section.

In making a comparison of failures for different lengths of time, it is pretty generally known that most of the failures of any lot of rails occur during the first four years.

The marking of the rails to distinguish the position in the ingot has become very general, but, of course, the position of most of them is still unknown. In general, the failures of "A" rails are the most numerous, but it is noteworthy that there are many failures down to "D" and "E" and occasional ones in "F." In some cases they are very numerous in "D" rails.

Thoughts Resulting from the Study.

(1) The study of these general statistics does not furnish accurate and specific information so as to determine the value of different sections of rail because:

The condition of traffic are different. The conditions of roadbed are different. The conditions of ingot making and rolling practice are so different that the quality of the material varies widely, and this difference in the quality of material eliminates differences in section.

(2) The study of these general statistics tends to disclose unusual results.

(3) The general statistics are also important in showing the relation between broken rails and failure of head, web and base.

(4) The tabulation of the statistics discloses the differences between steel companies when the sections and chemical composition are practically the same.

APPENDIX C.

Drop Test of Rails.

This report gives statements and tables of drop tests and chemical analyses of open-hearth rails rolled for the N. & W. Railway, giving results for heights of 15 ft., 18 ft. and 20 ft., and a comparison of the mill analysis with analysis of the borings from the rail. They were all 85-lb. rails of the A. S. C. E. section, except some 100-lb. A. R. A. section, type B made at Gary.

The tests were arranged for by C. S. Churchill, and made by J. A. Colby, inspector, at the various mills, through the aid of the manufacturers; and the chemical check analyses and reports thereon were made at the laboratory of the N. & W. Railway by J. H. Gibboney, chemist of the N. & W. Railway. The tests were made on a few melts of a regular rolling.

One piece for drop test was cut from extreme crop end of an "A" rail of each melt and subjected to test in a standard machine to a drop of 15 ft., and a very short section from this same piece was sent to Roanoke, Va., for analysis. In same manner two more pieces from other "A" rails of same melt were subjected to drop tests of 18 ft. and 20 ft.

The tup was 2,000 lbs., the anvil 20,000 lbs., spring supported and supports 3 ft. apart. The sets, also elongation of base and contraction of head under these tests, were noted over six 1-in. spaces.

From the first "A" rail, also from a lower rail from an ingot, taken at random from same melt, very short pieces were cut out for chemical analysis to furnish a comparison between the mill analysis and that of the rails, and the position of these chemical test pieces is noted in the statements.

AMERICAN STEEL RAIL MILL PRACTICE

COMPILED BY ROBERT W. HUNT & CO DEC. 12-1910.

Mill	Location	Kind of Steel	No. of Conv. or Furnaces	Size of Ingots at Bottoms	Nom. No. Ingots per Heat	Nom No. 80# Rails per Ingot	Bloom Mill Roll High	Nom. No. Passes Bloom Mill	Blooms Re-heated	No. of Passes Rail Mill Train	Total Passes Ingot to Rail	No of Hot Saws	No Extra Hot Saws	Dis from Fin Rolls to Nearest Hot Saw or One Com Used	Sec Time* between 1st Saw and Leaving Fin Rolls	Brand on Top or Bottom	Brand on Rail Reads from — to — of Ingots	
ALGOMA STEEL CO	ST STE MARIE CANADA	BESS. O H	2 3	18 x 19½	2 15	4-5	2	17	YES	11	28	1	1	113'	25-30	BOTTOM	TOP (GENERALLY)	BOT.
BETHLEHEM STEEL CO	BETH'M PA.	O H	10	19 x 23	25	6	2	15	NO	11	26	1	1	270'	35-40	"	BOT.	TOP
CAMBRIA STEEL CO	JOHNSTOWN PA.	BESS O H	4	19¾ x 22¾	4	5	2	15	YES	12	27	4	0	77'	15-20	"		
CARNEGIE STEEL CO	BRADDOCK PA.	BESS	4	18½ x 19½	7-8	4-5	3	7	YES	13	20	4	0	43'	12-16	"	BOT.	TOP
COLORADO FUEL & IRON CO	PUEBLO COL.	O.H	12	18 x 20	30	4	2	15	NO	10	25	1	0	105'	25-30	TOP	TOP	BOT.
DOMINION IRON & STEEL CO	SYDNEY N.S. CAN.	O.H	10	18½ x 21½	18	6	2	17	NO	11	28	1	0	107'	10-15	BOTTOM	TOP	BOT.
ILLINOIS STEEL CO.	GARY IND	O.H	28+	20 x 24	24	7	3-2	9	NO	9	18	5	0	158'	12-18	"	BOT.	TOP
ILLINOIS STEEL CO.	SO CHICAGO ILL.	BESS.	3	18½ x 19	6-7	4	3	9	NO	9	18	5	0	96'	10-15	"	BOT.	TOP
LACKAWANNA STEEL CO	BUFFALO N.Y.	BESS. O.H.	4 12	19 x 19	6 34	4	2	6	NO	9	15	1	1	232'	12-18	"	TOP	BOT.
LORAIN STEEL CO	LORAIN O.	O.H	6	22 x 26	20		2		YES					-		"		
MARYLAND STEEL CO.	SPARROWS PT. MD.	BESS. O.H.	3 5	19 x 21	6 16	5-6	2	13	NO	11	24	1	1		28-32	"	BOT.	TOP
MONTEREY IRON & STEEL CO	MONTEREY MEX.	O.H	4	17 x 22	16	4	2	15	YES	10	25	1	0	205	40-50	TOP	"	"
PENNSYLVANIA STEEL CO	STEELTON PA.	BESS. O.H.	3 5+	18½ x 18½	30	4	3	9	YES	11	20	2	1	8'	10-14	TOP		
TENN. COAL, IRON, & RR. CO	ENSLEY ALA.	O.H	8	19 x 23	30	6	2	11	NO	10	21	4	0	113'	15-20	BOTTOM	TOP	BOT

FIGURES ABOVE REPRESENT NOMINAL PRACTICE
LORAIN ROLLS CHIEFLY GIRDER AND HIGH TEE RAILS
IN 2 HIGH BLOOMING MILLS RAILS MAY BE GIVEN MORE THAN NO. PASSES ABOVE
PENNSYLVANIA ABOVE IS FOR STANDARD SECTIONS ONLY
TENNESSEE IS DUPLEX PROCESS STEEL
DOMINION " " " "
MARYLAND MAYBE " "
CARNEGIE MAY ROLL OH FROM HOMESTEAD

NOTE:- * REFERS TO TIME CONSUMED FROM ROLLS UNTIL 1ST RAIL IS CUT

American Steel Rail Mill Practice.

Carbon and Deflection of Rails in Drop Test.

This report covers a study of the influence of carbon on the deflection of a rail in the drop test and is based on the results of the drop tests given by C. S. Churchill. For this study the permanent deflection at 15 ft. was used and the analysis by Mr. Gibboney was used of the sample representing the outer part of the section of the rail, as the outer fibers have more influence on the deflection than the interior ones. Only those results were used where the outer and the interior samples show about the same composition.

The element having the most influence on the deflection is, of course, the carbon, and, judging from our knowledge of the influence of the elements on the tensile properties, it is probable that phosphorus exerts an influence and perhaps manganese does, also. Sulphur need not be considered, and probably silicon has only a minor influence, if any, in the quantities that exist in rail steel. At any rate, it cannot be considered in a preliminary investigation. In order to show up concisely what relationships may exist between carbon and deflection in the various lots of rail tested, I have plotted, in Fig. 1, the carbon-deflection diagrams for the Carnegie, Tennessee and Bethlehem rails, showing the per cent. of carbon horizontally

and vertically the permanent deflection of the base side of the rail under a 15-ft. drop.

In drawing the deflection curves, the "average" points or "centers of gravity" were given a weight according to the number of single points they represent. A few points that fell entirely out of their "zone" were ignored in drawing the curves. The curves are represented as straight lines and no attempt at closer fitting has been made, as with the small amount of data in hand and their small range, there must be considerable doubt as to even the slope of the line, let alone its curvature.

Of course, the deflection lines discussed above represent the combined effect of all the stiffening elements, although the slope would be due to carbon, providing the other stiffening elements were constant. It may be said that in general the phosphorous variations have had no influence on the slope of the carbon-deflection lines shown in Fig. 1. It seems probable that in the Carnegie and Tennessee rails that manganese has had no material influence on the slope of carbon-deflection curve.

It will be noted that within a carbon range from about .60 per cent. to about .75 per cent. the stiffening effect in these tests of a change .01 per cent. carbon was about .009 in. for the Carnegie rails, about .026 in. for the Tennessee rails, and about .021 in. for the Bethlehem rails, all being 85-lb. rails of A. S. C. E. section, with a nominal moment of inertia of 30.0

Very roughly, then this investigation indicates that above .60 per cent. each .01 per cent. carbon increase causes a decrease of deflection of base side of about .02 in. on 85-lb. O. H. rails of A. S. C. E. section when tested in the standard rail drop machine with tup of 2,000 lbs., span 3 ft. and height of drop of 15 ft.

The above study gives us some idea of the quantitative effect of carbon on the deflection of a rail in the drop test, but offers no information as to the effect of other elements. It would seem desirable, however, to know the exact quantitative effect of each factor having an influence on the deflection, so the information could be summarized in one or more formulas, and it is hoped that experimental work may be continued with this end in view, particularly since such information would seem very desirable for use of the sub-committee dealing with specifications.

In this connection I wish to offer some thoughts as to the form the formula should take. Starting with soft iron without any hardening elements, the deflection under a given height of drop would be decreased with each increment of hardening material. It would be increased with an increase in the height of drop and decreased with an increase of the moment of inertia of the section and, perhaps, temperature of rolling should also be taken into account. The formula for deflection would then take the following form:

$$d = (K - cC - pP - mMn)\frac{h}{I}$$

where
d = deflection
K = constant for soft iron
C = carbon
c = constant for carbon
P = phosphorus
p = constant for phosphorus
Mn = manganese
m = constant for manganese
h = height of drop
I = moment of inertia

It is readily possible or even probable that the constants would change with different classes of steel, but the above form of the formula would probably be suitable for all of them, except we may find that the manganese factor may be omitted, and possibly also the phosphorus in special cases, and again, as stated, temperature of rolling may have to be reckoned with.

APPENDIX D.

A Study of Forty Failed Rails.

This report, made by W. C. Cushing, covers a study of forty rails which failed in the main tracks on the Southwest System of the Pennsylvania Lines West of Pittsburgh during the year 1909. The detail reports of the individual rails cover in most cases: 1. A statement of track conditions. 2. General photographs of the failure. 3. Photograph of the etched section. 4. Microphotograph in some cases. 5. Chemical analysis, from interior of head. 6. Physical test, from interior of head.

Sixteen broken rails were examined, and thirteen out of the sixteen were broken in or at the splices. Of these thirteen, two were Weber joints, one Bonzano, and ten six-hole splice bar. Each of these rails was considerably worn in the splicing space, but the metal of five of them was hard and brittle, and in some cases the constituents were considerably segregated.

The result of the eaxmination of twenty-four rails which failed from crushed or split heads showed that all of the failures were caused either by hard, brittle, unsound or segregated metal, or a combination of two or more of them. In three cases investigation showed that foreign material was rolled in the rail section. In one case it was very apparent that this foreign material was an old tie plate. The trouble appears to have occurred from the practice at the Gary mill

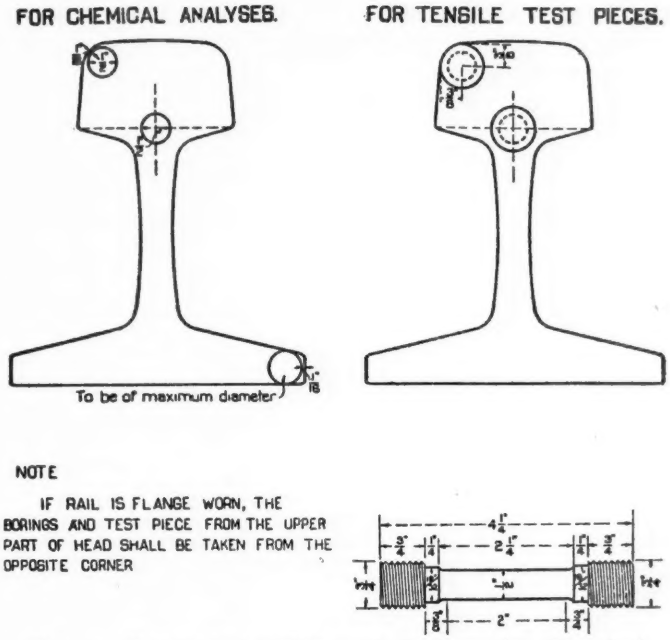


Fig. 1. Standard Locations of Borings for Chemical Analyses and Tensile Test Pieces.

of throwing pieces of scrap on the stool to prevent its cutting during the casting of the ingot.

Mr. Cushing concludes that these forty cases of rail failure point out very clearly that the prime cause of rail failures is the poor quality of the material, as indicated by hardness, brittleness, segregation and unsoundness, all of which must be corrected in the ingot. Only two cases of faulty rolling were found in this lot.

A Study of Sixty-Eight Failed Rails.

This report covers a study of sixty-eight additional rails which failed on the Southwest System of the Pennsylvania Lines West of Pittsburgh, except a few which failed on the Rock Island System.

From this study Mr. Cushing concludes that it is quite

Weight of Rail	Figures below are percentages of total failures							
	Broken		Head Failures		Web Failures		Base Failures	
	Bess.	O. H.	Bess.	O. H.	Bess.	O. H.	Bess.	O. H.
100	20	19	58	40¾	14½	28¼	7½	12
90	17	34	74	50¾	6	12	3	3¼
85	16	21¼	69¾	63¾	6¼	9	8	6
80	15¾	15	73	60	6¼	19	5	6
75	28	..	51½	..	17½	..	3	..

clear that the new rail sections, neither the P. S. section with the heavy head, nor the A. R. A. A. section with the thinner head, have yet brought about any improvement in the quality of the metal by reason of better proportionate distribution of the material in the head, web and base, respectively, in the hope that the conditions of rolling would be so improved as to produce sound material.

The defects must be remedied at the blast furnace, and the changes of improvement must bring about less segregation of the elements and smaller inclusion of gas bubbles and slag, in whatever way the results are to be accomplished, whether it be by more time for the mixing of the elements

and the escape of the gas, or in some other way not yet discovered.

In discussing Mr. Cushing's results, Mr. Wickhorst says that rail failures may be roughly divided in two classes, "broken" rails and "split" rails; the first class including square breaks, angular breaks, and perhaps also broken bases, and the second class including split heads and split webs. Broken rails, according to this lot of failures and the failures summarized on page 259 of part 1 of the 1910 Proceedings of the American Railway Engineering and Maintenance of Way Association, constitute about 30 per cent., and the split rails about 70 per cent. of all rail failures. The material in about half of the broken rails shows satisfactory on test, while the material in the other half shows more or less defective. This means, it would seem, that poor quality in the rail is a contributory rather than a primary cause for the break.

The split rails generally show segregated material from the upper part of the ingot. In fact, this condition is so frequent that we may say that in general split rails are confined to this kind of material.

APPENDIX E.

Tests and Conclusions by M. H. Wickhorst.

Eleven reports have been made, covering the following subjects:

Nos. 1 and 2. Tests of Bessemer Rails—Maryland Steel Company.

No. 3. Tests of Titanium Bessemer Rails—Lackawanna Steel Company.

No. 4. Tests of Bessemer Rails—Illinois Steel Company, South Works.

No. 5. Tests of Open-Hearth Rails—Gary Works.

No. 6. Tests of Bessemer Rails—Edgar Thomson Works, Carnegie Steel Company.

No. 7. Investigation of a Split Head Rail.

No. 8. Segregation as Influenced by Fire-Clay on Ingot.

No. 9. Strength of Rail Head.

No. 10. Drop Test of Rails—Effect of Impact Energy Variously Distributed.

No. 11. Flow of Rail Head Under Wheel Loads.

Drop Test.—The height of drop that a piece of rail will stand depends upon its position in the ingot. Starting from the top of the ingot, the height that is just sufficient to break the rail at first decreases until a "brittle zone" is reached, when the rail may only stand a few feet fall of a weight of 2,000 lbs. Passing this, the allowable height rapidly increases and remains roughly uniform for the rest of the rail bar. The heights called for in various specifications vary from fifteen feet to twenty feet. Close to the top of the ingot the rail may stand such a height, but in the brittle zone, with some makes of material, the rail may stand only five feet or less. In the lower part of the ingot the rail may be able to stand heights of forty to eighty feet, or even more. Just where the brittle zone is in different materials and with different size ingots has not been determined, but an extensive investigation should now be undertaken to work this out.

Segregation.—When molten steel is poured into the ingot the different constituents that compose the liquid mass do not stay together when solidifying, but the carbon, phosphorus and sulphur tend to collect or "segregate" toward the interior and upper part of the ingot. The region of maximum segregation seems to correspond in location with the brittle zone developed by the drop test. The tests indicate that a small amount of segregation is not harmful, but the allowable limit has not been determined.

The problem of ingot making apparently consists of controlling segregation as to maximum allowable limit, and as to location in the ingot, so a small discard will always remove it.

Split Heads.—It has been shown that at least some rail failures, such as are ordinarily classed as split heads, are due to excessive segregation, which results in very fragile metal in the interior of the rail, as explained in detail in report No. 7.

Pipes and Laminations.—Our tests show that laminations occur most frequently in rail from near the top of the ingot, but may occur in any part of the rail bar. They also show that laminations, in themselves, have no relation to the results in the drop tests. Some of the worst drop tests have shown no laminations, while the worst laminations noted have been attended by some of the best results in the drop tests.

Rolling—Our work so far does not show very definitely the influence of such matters as speed of rolling, number of passes in reducing from ingot to rail, temperature of rolling, distribution of rail sections, etc., but they indicate that such matters are of relatively small importance.

Conclusion.—In conclusion, our work of the last nine months has shown fairly definitely that the matter of making safe rails, and in which the different rails of the lot will wear uniformly, is almost entirely a matter of making a good ingot free from excessive segregation, or of cropping off sufficient from the top to remove such excessive segregation.

Investigation of a Split Head Rail.

This report covers a study and tests of a very interesting and instructive rail that failed due to a split head, and is intended to throw some light on the cause of failure. This rail was one of a number that failed in a somewhat similar manner in a lot of 80-lb. A. S. C. E. rails laid in about October, 1909, by the Wabash R. R. on straight track in its main line near Adrian, Mich. It was a 33-ft. Bessemer rail, made at the Edgar Thomson Works at Braddock, Pa., of the Carnegie Steel Company, in September, 1909, heat number 11508. It was removed from service in May, 1910. The rail had no letter showing its position in the ingot. The total tonnage over this rail was about 4.3 million freight tons and the passenger trains additional. The heaviest engines that ran on this rail weighed 103 tons, with a maximum weight of 14 tons per driving wheel. The bearing on the ties as shown by the rust marks on the bottom of the rail averaged 7½ inches and the tie spacing as determined by measuring from center to center of the rust marks averaged 22 in.

The examination consisted of etchings with copper potassium chloride of a large number of transverse and horizontal longitudinal sections cut from the rail, chemical analyses, tensile tests of specimens cut from the rail and microscopic examination.

A rail in service tends to widen at the upper part of the head, that is, the upper part of the head extends transversely. The amount of widening varies considerably with different rails, some showing but little and others a large amount. The compressive effect of the rolling wheels evidently causes the metal to flow transversely, and this flowing seems always to be greatest at about the top of the rail. The metal at the top of a rail is practically always ductile material, but the metal in the interior of the head may sometimes be brittle and incapable of transverse extension, and in such a case, when the top flows and widens, the interior metal, as it cannot stretch likewise, must develop a crack. Of course, anything which takes away the ductility of the metal in the head in a transverse direction would allow of the formation and development of cracks, as, for instance, slag enclosures, seams and laminations, due to gas holes and pipes, or bad segregation. In the case in hand the splitting of the head seems to have been due to bad segregation of the carbon and phosphorus. The metal seems to have been good metal in the ladle, but it evidently went to the bad in the making of the ingot, although the dangerous segregation could, indeed, have been removed with a sufficient discard from the top. This suggests that it would be desirable to make a somewhat comprehensive study of such matters as size and shape of ingot and other conditions influencing segregation.

After a crack has opened up, the metal above it, of course, tends to flow into it under the action of the wheel loads, and after this metal has reached the limit of its ductility in compression, it shears along diagonal lines, resulting in the "wedge" generally seen above a crack. The crack generally comes to the surface at the underside of the head at its junction with the web, although occasionally it runs down into the web and comes to the surface at the side of the web.

Segregation as Influenced by Fire-Clay on Ingot.

This report covers tests made to investigate the effect on segregation of putting fire-clay on the ingot directly after pouring. During the regular pouring of a heat of Bessemer steel of six ingots, two of the ingots were selected for test, one of which was without any covering, and the other of which was covered directly after pouring with a half-shovelful of fire-clay, equal to about two pounds. They were made at the Edgar Thomson Works of the Carnegie Steel Co. at Braddock, Pa., on August 9, 1910, heat 5,101. Mixer metal and scrap steel were blown and poured into the teeming ladle, liquid spiegel being poured in at the same time. The metal was then poured at once into the molds, without any other addition. The ingots were 18½x19½ at the bottom. The stools and molds had been sprayed with a wash of fire-clay. The metal set quietly in both ingots. The uncovered ingot hardened quickly on top, while the covered ingot remained liquid on top for some time.

After being in the soaking pit for about 1 hr. 40 min., the ingots were bloomed to 9½x9½ inches, and instead of making the usual discard from the top, as little as practicable was sheared off. The usual practice at this mill is to cut the bloom into two billets, making the large discard from the top and a small one from the bottom. Each of these billets makes two rails. In the present case, as stated, only a small amount was sheared from the top, and the rails from the top

billet were reserved for this investigation, which happened to be 90-lb. A. R. A. type B section. Previous to rolling into rails, the billets were run through a reheating furnace.

The investigation consisted of drop tests, chemical analyses and etchings of sections. The A and B rails of each ingot were divided into units.

This study seems to show that with a Bessemer ingot weighing about 5,000 lbs. the effect of covering it with fire-clay directly after pouring is to cause the greatest segregation to go higher toward the top of the ingot and also to increase its concentration. A small discard, say less than 10 per cent. from the top, does not remove the zone of maximum segregation from either the plain or covered ingot, and the segregation would be worse in the covered ingot. A large discard of 20 per cent. or over removes it more effectively from the covered ingot. This whole study, however, can be taken only as an indication and seems to show strongly the need for a thorough study of the whole subject of ingot-making. Ingots of different sizes and shapes, made of both Bessemer and open-hearth steels and with different treatments, should be made and thoroughly studied, by testing the rails made from them and, what is perhaps more important, by also testing the ingots themselves. Etchings and analyses should be made of various ingot sections to determine accurately the distribution of the various metalloids and of cavities, slag, etc.

Strength of Rail Head.

This report covers tests made to determine the strength of the head of the rail with the load concentrated at the edge of the top surface. Tests were made with a 200,000-pound test machine by canting a piece of rail 18 inches long and applying the load at the edge by means of a block with a radius of 16½ inches to represent a car wheel where it came in contact with the rail. Other tests were made with a reciprocating machine representing a loaded wheel rolling back and forth on the edge of the canted rail. These tests were made at Sparrows Point, Md., at the works of the Maryland Steel Company, who kindly furnished all the material and facilities for them, and were made especially for the sub-committee dealing with rail design. For these tests a rail was taken from stock and six pieces, each 18 inches long, were cut from it for test in the stationary test machine, and six similar pieces were used for test in the reciprocating machine. In order to have the material as uniform as possible throughout the section and in the different pieces a C rail was selected, that is, the third rail from the top of the rail bar. The rail was a 90-pound A. R. A. type B section and the pieces were planed down to thicknesses of head at the side of ⅜ in., ½ in., ⅝ in., ¾ in., ⅞ in., and 1 in., two pieces of each thickness, one for each kind of test. In each case the brand side of the head of the rail, which was the bottom side as rolled, was planed vertical to a width of 1$\frac{1}{16}$ inch from the center line.

The arrangement used for making the stationary tests is intended to represent a 33-inch car wheel resting on the edge of the top of the rail. The head is thus tested as a cantilever, the load tending to sag the head locally and to also bend the web.

The load was applied in increments of 10,000 lbs. up to 60,000 lbs. and then in increments of 20,000 lbs. up to 200,000 lbs., the capacity of the test machine. The sag of the head was determined by measuring the distance by means of dividers, between prick punch marks placed on the side of the head near the bottom and on the base, the load being on while taking the reading. The marks on the base were placed about one inch from the web, by gouging some of the metal so as to have a vertical surface on which to prick punch the mark. The amount that the opposite side of the head elevated or the "lift" was determined in a similar manner.

The curves show that a load of 10,000 lbs. does not sag the head with the load applied to the edge of the top side, with any thickness down to ⅜ inch, and probably neither does a load of 20,000 lbs., although, as the load was on when the measurement was taken, we cannot say how much of the sag was elastic and how much permanent. A load of 30,000 lbs. seems to cause a permanent sag with the ⅜-inch head, but not much, if any, with the heads of greater thickness. It had been hoped to determine by these tests the maximum load which each thickness of head would carry, but it is now clear that in any future work of this kind the measurements should be taken after releasing each load, as well as while it is on, and it would also be desirable to make the measurements with a micrometer reading to .001 inch. With these changes it would seem that this test should give this information in a reasonably satisfactory manner.

It is interesting to note in this connection that the web seemed to stand the load of 200,000 lbs. successfully.

Tests were also made with a reciprocating machine in which a piece of rail is moved back and forth under a wheel to which a load can be applied by means of a system of levers.

DROP TESTS OF RAILS.

The tests described in this report were made to compare the results of a given amount of impact energy, variously distributed, as, for instance, in one blow, and the same foot-pounds divided among several blows; also, for instance, the relative effects of tups of different weights, but with heights adjusted to deliver the same foot-pounds of impact.

The drop tests were all made with the base in tension, the rail being placed with its base downward on supports 3 ft. apart with radii of 5 in. The permanent deflection or set was measured both on the top side, including the depression caused by the tup, with a striking radius of 5 in., and on the base side, which latter measurement gave only the actual permanent bending of the rail.

FLOW OF RAIL HEAD UNDER WHEEL LOADS.

The tests covered by this report were made to determine, if possible, what change is made in the microstructure of the head of the rail by the rolling over the rail of heavy wheel loads. At the same time, measurements were made of the spread of the head and the width of the bearing produced. The tests were made at Sparrows Point, Md., at the works of the Maryland Steel Co., who kindly furnished all the material and all the shop and laboratory facilities to make them. They were made on the reciprocating machine by moving a piece of rail back and forth under a loaded cast iron car wheel. The desire was to simulate rather severe service conditions, and a light thin head rail was used. A 70-lb. Bessemer rail was selected from stock, and in order to have material fairly uniform throughout the section and in such several pieces as might be used for test, a "D" rail, that is, the fourth rail from the top of the rail bar, was used, heat 45,437 and fourth ingot of the heat. The piece of rail tested was 12 ins. long, which was set up between two other similar pieces, which acted as end pieces onto which the wheel could roll when leaving the piece under test. The piece tested had the sides of the head planed vertical to a width of head of 2 ins. This width was used partly to accentuate the test and partly to do away with the rounded corner, so as to allow of measuring the width closer to the top of the head, and the sides were made vertical so the measurements could be made satisfactorily with a micrometer along the whole depth of the head.

The test was started with a load of 30,000 lbs. applied to the wheel, using 1,000 double strokes or 2,000 rollings of the wheel over the rail under test. The bearing assumed a width of .64 in. The only effect on the width of head was to spread the top of the head .002 in., and the load was therefore increased at once to 60,000 lbs. and the test continued until the head seemed to no longer spread as measured with the micrometer.

It is also seen that under the conditions of this test and with the load and material used, about .8 of the maximum results was produced by the first 5,000 rollings, and almost the maximum by the first 10,000 rollings. The 22,000 rollings beyond this produced but little additional spreading of the head.

Discussion on Rail.

Mr. Churchill: Referring to the form for reporting rail failures, it is an important matter to show, in case a rail fails, which side of the track the rail was taken from.

Mr. Lindsay: The section foreman's information is not always reliable. He will report that the track was all right, joints all right, road bed all right, yet the track broke. I believe we should have a question in there, "did the rail have a full bearing upon the tie plate"?

Mr. Churchill: I am a little afraid that we woulld get the same sort of an answer. I believe where a break occurs that is not very clearly explainable at first sight on the foreman's report, there should be an examination by somebody else much higher up than the track foreman, and I think that is the practice on most of the roads today. I am afraid, if we make our report too cumbersome, we will not get it answered in any intelligent manner.

Mr. Lindsay: Referring to the changes recommended in Form 405, I do not understand that it will be necessary to change our definition of a broken rail—"this term to be confined to a rail which is broken through, separating into two or more parts. A crack which might result in a complete break will come under this head." In consultation with the officer of Public Service in the state of New York on this subject, the definition of a broken rail, for the purposes of report to the state, reads as follows: "For the

purposes of this yearly report, a rail shall be considered as having broken when complete fracture into two or more parts has taken place, when there is any break in the head of the rail on the gauge side, or when there is any other break necessitating either the immediate removal of the rail from the track or its reinforcement."

Mr. Cushing: The classification as adopted by the rail committee is based on the common classification generally given by the men who see the failures in service and is intended to explain them as nearly as one would explain them by seeing them on the track. The person reporting this, knows nothing about internal defects and consequently we have attempted to have the different classifications about as they are generally described. The information for the public service commission can be given from these reports by adding together several classifications given by the committee to make up what the public service commission calls a broken rail.

Mr. Lindsay: Conclusion 4 covers the general method of taking borings for chemical analyses. Last night we saw a section of an ingot showing the way segregation takes place. I would like to ask the committee if that segregation is reasonably symmetrical around the vertical axis.

Mr. Churchill: Yes, it is approximately so. The great mass of material at the bottom of the head brings the center of segregation or defective material, from whatever cause, near the junction of the head and the web. It of course extends down, as you saw in the picture, through the web and into the flange, but the web is so thin, if you attempt to take borings, you will get mixed material. For this reason, if for no other, the best location is near the base of the head, where you are sure to get a mass of material that is questionable, in a questionable rail.

C. E. Lindsay (N. Y. C. & H. R.): In looking over reports of causes of our broken rails I find that a very large percentage of the breaks occur on the left hand rail; as high as 90 per cent in some months. In looking further, I have been able to locate some defects due to defective equipment, and in tracing that up, I have reports of flat wheels passing over the road. Following that up, I always found that the car inspector's report showed that the wheel was examined before it left the terminal, and the flat spot was within the limits prescribed.

Would it not be possible to put a flat wheel on the machine that was shown last night for testing the pressure of wheels on the rail to see the effect of flats of different lengths on the rail and whether it is possible to break a rail with a flat wheel?

Mr. Wickhorst: That machine you saw illustrated last night moves at slow speeds, and we could not get the speed effect in it. Mr. Lindsay will find in the proceedings of the American Society for Testing Materials, several years back, some discussion I presented on the cause of breakages on the left hand side. The reason that is given there is that the locomotive is so built that when the counter-balance is down, giving the heaviest vertical load, the engine noses to the left at the same time.

E. F. Wendt (P. & L. E.): During certain months of the winter one hundred per cent of the broken rails occur on the left hand side of the track. The system of records now in use is so complete that we have before us this data.

Mr. Churchill: You are speaking of what must be classed as broken rails under the definition?

Mr. Wendt: I am speaking of rails actually broken and removed promptly.

Mr. Wickhorst: That preponderance of broken rails on the left hand side applies probably to what you would call cross sectional breaks or base breaks. It does not seem to apply to longitudinal breaks such as split heads. I have tried to notice that point in looking over track, and what little information I have secured indicates that it does not make much difference with the latter class of breaks.

W. H. Elliott (N. Y. C. & H. R.): The data on the blow or pressure on the rail for various points of counter-balance of a locomotive wheel were worked out very fully in 1892 in the proceedings of the Master Mechanics' Association. It was then shown, as I recall it, that the left forward driver of an American locomotive is the heaviest of the four driving wheels, but there did not appear to be a difference in blow delivered on the rail to account for such a great difference in the breakages between the left and right hand rail. I would suggest that this matter be taken up with the Master Mechanics' association by our committee, and the blow or weight of the wheels for the drivers of the Pacific type of engines be determined. This matter, I believe, was very fully considered by that association in connection with the wear of tires to account for the driving wheels almost universally wearing more at a certain point midway between the crank position and the counter-balance. It is not directly opposite the counter-balance, but a little ahead of it.

R. N. Begien (B. & O.): This is a matter which we now have under consideration. We have noticed, on our Chicago Division, that practically 90 per cent of breakages in the rails occur on the left hand side. Possibly the use of a heavier rail on the left hand side might be better.

Mr. Kenly: The thought occured to me that probably the broken rails on double track result from loose, or relatively loose track, on the inside rail, due to the fact that the track is not so well drained at the middle between the double tracks, as it is on the outside, and that probably the number of loose ties, or loose heads in the inside rail on the double track, is more the cause of the broken rails than is the thrust, or impact of the engine on the left hand side. I do not know whether we have any information to show that there is more bad surface on the inside rail than on the outside rail, but it occurs to me that that is the cause for broken rails in the case of double tracks.

The President: The committee suggests that is a matter for investigation by the committee on track.

Mr. Churchill: In the matter of specifications, we are somewhat in the same position we were a year ago. We have not gotten much closer. The difference, however, was not very great and we expect during this year to get together. As to the matter of rail sections, we cannot determine at this date with so few rails of the newer sections in use for such a short time which are better, but these reports that are coming in and will come in during this year, and the additional investigation by Mr. Wickhorst and by others interested will help us.

Mr. McDonald: In the matter of the testing of rail joints, I have heard it stated by representatives of manufacturers that some of the joints submitted had been specially prepared for that test and that others had not. I think in order to avoid that it would be well in future for the committee to select their samples from the general run rather than have any special samples.

Mr. Churchill: I think in every instance the joints were taken from stock. There was probably one instance of a joint that came from a manufacturer. Any joint that happened to be in the storehouse was taken on my road. I know that other roads did the same thing. If our report points to anything it is the importance of looking out more carefully for the character of the steel used in rail joints, whoever makes the joint.

TRACK.

The following sub-committees were appointed:

Frogs and Crossings: L. S. Rose, chairman; J. C. Nelson, R. M. Pearce, R. H. Howard, C. H. Stein, R. C. Falconer.

Switch Points: H. T. Porter, chairman; S. S. Roberts, P. C. Newbegin, G. J. Ray, R. A. VanHouten, J. R. Leighty, T. H. Hickey.

Track Fastenings with Treated Ties: Dean Wm. G. Raymond, chairman; Garrett Davis, F. A. Smith, W. D. Wiggins, J. L. Downs.

Spirals: J. B. Jenkins, chairman; Dean Wm. G. Raymond.

REVISION OF MANUAL.

After giving that portion of the Manual pertaining to track much discussion, it was decided that changes be recommended as follows:

(1) Maintenance of line, section (b), for the adjustment of curves, should be changed to read as follows:

"Longer easement curves than the minimum lengths recommended may be used to advantage, and even with increased convenience in their application, but any considerable increase in length is wholly unnecessary and should never be made without careful consideration as to the effect on cost. For minor curves, an increase in length of about 50 per cent. over the minimum is recommended when such increase will not seriously affect the cost, nor adversely affect the degree of curve. The minimum length recommended should be used in all cases where greater length would adversely affect the degree of curve."

(2) Following the last paragraph under section (b), the following should be added.

"The 10-chord spiral, computed by dividing the spiral into 10 equal parts, is recommended. Chords of any length may be used in staking out the 10-chord spiral when the central angle is small. Chords approximating one-tenth the length of spiral should be used when the central angle exceeds 15 degrees."

(3) Maintenance of Surface. The third paragraph following the table of elevation of the outer rail should read as follows: "Ordinarily an elevation of eight inches

should not be exceeded. Speed of trains should be regulated to conform to the maximum elevation used."

(4) Maintenance of Surface, section (a), recommended practice. The following paragraph should be stricken out: "In ordinary practice it is recommended that the elevation be run out at the rate of one inch in 60 feet, but this will be modified by the same conditions that would vary the length of the easement curve used."

(5) Maintenance of Gage, section (a). Paragraph 1 should read as follows: "Tie plates are recommended in all cases where economy in maintenance will result from their use."

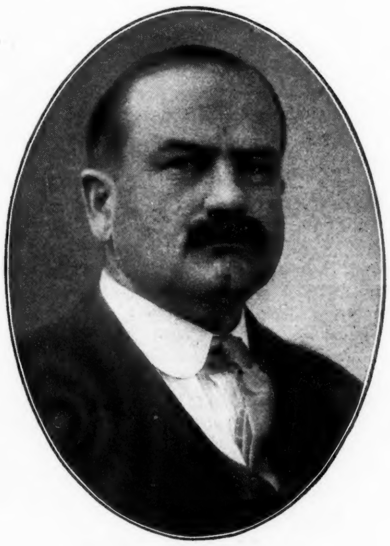
GENERAL INSTRUCTIONS FOR ORDERING OR CONTRACTING FOR FROGS, CROSSINGS AND SWITCHES.

Manufacturers shall submit for approval detail shop drawings showing construction and dimensions of all parts to be furnished in accordance with these specifications. The drawings shall be on sheets twenty-two (22) in. wide, with a border line one-half (½) in. from the top, bottom and right-hand edge, and one and one-half (1½) in. from the left-hand edge. The standard length of drawings shall be thirty (30) in., except that, when necessary, longer sheets may be used and folded back to the standard length.

Drawings of one subject only shall appear on a sheet.

Scale of general drawings shall be 1½ in. = 1 ft., details not less than 3 in. = 1 ft. Conventional shading shall be used in sectional drawings. All dimensions and distances shall be shown plainly in figures.

The title shall be placed in the lower right-hand corner.



C. E. Knickerbocker.
Chairman, Committee on Track.

All drawings are intended to form a part of the specifications. Anything which is not shown on the drawings but which is mentioned in the specifications, or vice versa, or anything not expressly set forth in either, but which is reasonably implied, shall be furnished the same as if specifically shown and mentioned in both. Should anything be omitted from the drawings or specifications which is necessary for a clear understanding of the work, or should any error appear in either the drawings or specifications affecting the work, it shall be the duty of the manufacturer to notify the company and he shall not proceed with the work until instructed to do so by the company.

SWITCHES.

Lengths.

1. 11 ft., 16 ft. 6 in., 22 ft. or 33 ft.

Throw.

2. 5 in. at center line of No. 1 rod.

Gage of Track.

3. 4 ft. 8½ in.

Switch Rails.

4. Side planing and bending shall conform to a spread at the heel of 6¼ in. between the gage lines of the stock rail and the switch rail. The gage lines of switch rails shall be straight. The head of switch rail shall fit neatly against the head of stock rail from point of switch rail to point of divergence. The face of web at the point shall be in a vertical line with the inside edge of the head of stock rail.

Top planing shall conform to the measurements shown on Fig. 1 and Table 1.

TABLE 1.

Switch.	A B
33 ft.	12 in.
22 ft.	9 in.
16 ft. 6 in.	5 in.
11 ft.	5 in.

Bottom of switch rail shall be planed to fit neatly on base of stock rail where bases overlap.

The point of switch rail shall be as shown by Fig. 2.

Holes for switch rod lugs and stop blocks shall be 25/32 in. in diameter and 5 in. center to center. Holes for reinforcing bars shall be 25/32 in. diameter. Number and location as provided under Reinforcing Bars.

Lugs.

5. Lugs shall be as deep as the section of rail will permit and of standard design, as shown in Fig. —. Distance between centers of holes for bolts running through the web of the rail shall be 5 in., diameter of holes shall be 25/32 in.

Distance between web of rail and center of switch rod bolt holes shall be 5 in. Switch rod bolt hole shall be 1 1/32 in. in diameter.

Switch Rods.

6. Switch rods shall be of the standard design, as shown in Fig. —. Rods shall be ¾ x 2½ in. and shall be held in a horizontal plane. Bolt holes shall be 1 1/32 in. in diameter. There shall be at least 1½ in. of metal at end beyond bolt holes.

Rods shall be stamped with ¾-in. letters showing the weight, section of rail and number of rod, the point rod being No. 1.

Reinforcing Bars.

7. A reinforcing bar ⅜-in. thick shall be riveted to each side of each switch rail and point ends shall be made flush with point of switch rail. The bars shall be as long as the heel connections will permit. Bars shall fit against web of rail and shall fill the space between head and flange of rail. There shall be ⅛-in. clearance between outer bar and head of stock rail where the bar projects under head of stock rail, and the top of inner bar, where it projects beyond the head of switch rail, shall be not less than 1⅞ in. below the top of stock rail.

Bars shall be fastened to rail with ¾-in. rivets, except that the first, second, fifth and the holes through which the lugs are fastened shall be bolted. Center of first hole shall be 1½ in. from point and center of last hole in bar to be 2 in. from heel end of bar. Intermediate rivets shall be spaced so that there shall be fastenings at intervals not greater than 12 inches.

Stock Blocks.

8. Stop blocks shall be of approved design with two holes 13/16 in. in diameter and 5 in. apart. Blocks shall be spaced after switch is placed in track as nearly as practicable at equal intervals between the end of planing and heel of switch.

Bolts and Nuts.

9. Bolts fastening lugs and stop blocks and foot guards to switch rails shall be ¾-in. in diameter. Bolts connecting lugs with switch rods and the switch-stand connecting bolt shall be 1 in. in diameter and machine turned. All bolts shall be provided with nut locks and cotters. Nuts shall be hexagonal.

Plates.

10. There shall be on each tie two plates, ⅞-in. by 7 in., planed down to receive the stock rail and braces. Three 15/16-in. holes outside and two inside are required for ⅞-in. lag screws or screw spikes on all switch ties, except the two head ties, where there shall be three outside and four inside.

Braces.

11. Braces shall be of such a design that 2½-in. clearance for detector bars may be obtained. Three holes for ⅞-in. lag screws or screw spikes shall be provided.

SPECIFICATIONS FOR MANGANESE IN FROGS, CROSSINGS AND SWITCH POINTS.

The committee has investigated so far as has been practicable this year the question of specifications for manganese in frogs, crossings and switch points, but thinks that this subject should be further investigated and that careful records and experiments covering a period of years

should be recorded before it is in a position to recommend a specification that will meet with approval.

TRACK FASTENINGS WITH TREATED TIES.

The following statements seem to be warranted by a study of the replies to circular letters:

(1) Tie-plates with some form of fastening which can be removed and replaced at will without injury to the wood fibers are desirable. Your committee feels that such a fastening has not as yet been fully demonstrated.

(2) In shoulder tie-plates the holes for outside fastenings should be so placed that the base of the rail bears only against the body of the fastenings.

(3) Tie-plates should be flat bottomed, as projections of any kind tend to destroy the tie. One striking photograph is shown of a treated bridge tie entirely sound except where the projections of the plate have injured the fiber. This effect would perhaps be lessened if the tie-plate were independently fastened to the tie by screws other than the rail fastenings, and by use of the principle mentioned in paragraph 5.

(4) The bearing surface of tie-plates should be proportioned by each road to the resistance of the wood most largely used for ties on its line. In general, plates six

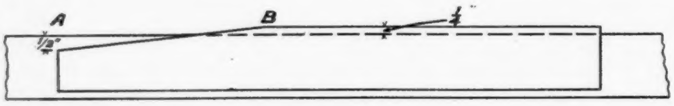


Fig. 1.

inches wide for hard woods and seven inches wide for soft woods should be sufficient, but some roads report trouble with plates of these widths.

(5) A tie-plate thicker through the whole or a part of the middle of its length than at the edges, with only a central bearing, is suggested for trial as theoretically sound. There would be less tendency for such a plate to rock under the action of the passing load and less pressure tending to force first one edge and then the other into the tie, and the plate would be strongest where the bending moment is greatest. The essentials of such a plate are the thicker central portion and the central bearing of the rail.

CONCLUSIONS.

The committee recommends:

(1) That the changes in the Manual, as proposed, be adopted.

(2) That the title of the specifications for spring and rigid frogs adopted by the convention of 1910 be changed to read: "General Specifications for Frogs, Crossings and Switches."

(3) That the General Instructions for Ordering or Contracting for Frogs, Crossings and Switches, as given in the report, shall be prefixed to the specifications mentioned above.

(4) That the plans for rigid and spring frogs, submitted with the report, be adopted and added to the specifications for the frogs, crossings and switches.

(5) That the specifications for switches submitted be adopted and added to the specifications for frogs, crossings and switches.

(6) That the report on Track Fastenings used with Treated Ties be accepted as a progress report.

(7) That the report on Spirals be adopted.

The report is signed by: C. E. Knickerbocker, N. Y. O. & W., chairman; J. B. Jenkins, B. & O., vice-chairman; Garrett Davis, C. R. I. & P.; J. L. Downs, Y. & M. V.; R. C. Falconer, Erie; T. H. Hickey, M. C.; R. H. Howard, Chicago, Ill.; C. B. Hoyt, N. Y. C. & St. L.; John R. Leighty, M. P.; J. C. Nelson, S. A. L.; P. C. Newbegin, B. & A.; R. M. Pearce, P. & L E.; H. T. Porter, B. & L. E.; G. J. Ray, D. L. & W.; Wm. G. Raymond, State University of Iowa; S. S. Roberts, Louisville, Ky.; L. S. Rose, C. C. C. & St. L.; C. H. Stein, C. R. R. of N. J.; F. A. Smith, Civil Engineer, Chicago, Ill.; R. A. Van Houten, L. V.; W. D. Wiggins, Pennsylvania, committee.

APPENDIX A.

Spirals.

A preliminary examination was made of a number of curves to determine their relative adaptability for use as a railroad spiral, the examination comprising the cubic parabola, a curve whose deflections vary as the square of the distance, the Searles spiral, the Stevens six-chord spiral, a curve whose radius is inversely proportional to the length of arc, as developed by Crandall and Talbot, a curve whose degree increases with the number of 100-ft. chords, and a curve whose chords subtend a constant and inflexible series of central angles. All the above curves accomplish the required results in easing the approach to a circular curve, some less perfectly than others, but still satisfactorily; but in attempting to derive formulas for the various spirals, some one of the following difficulties was experienced in each case. (1) If simple, approximate formulas were used they were not sufficiently accurate. (2) Accurate formulas were too complex. (3) The curve could not be expressed by formulas. (4) Formulas were of the endless-series class. (5) Complex field methods were required to make the field work agree with formulas with spirals of large central angles.

The committee then investigated a practical adaptation of the spiral as developed by Crandall and Talbot in which the curve is considered to be measured by ten equal chords; this curve was found to be susceptible to expression by definite formulas which compare favorably as to simplicity with those of other spirals, the formulas being accurate beyond the degree of accuracy attainable in the most careful field work if the application of the formulas be restricted to such spirals as may actually be required in practice. Tables developed from this formula were presented.

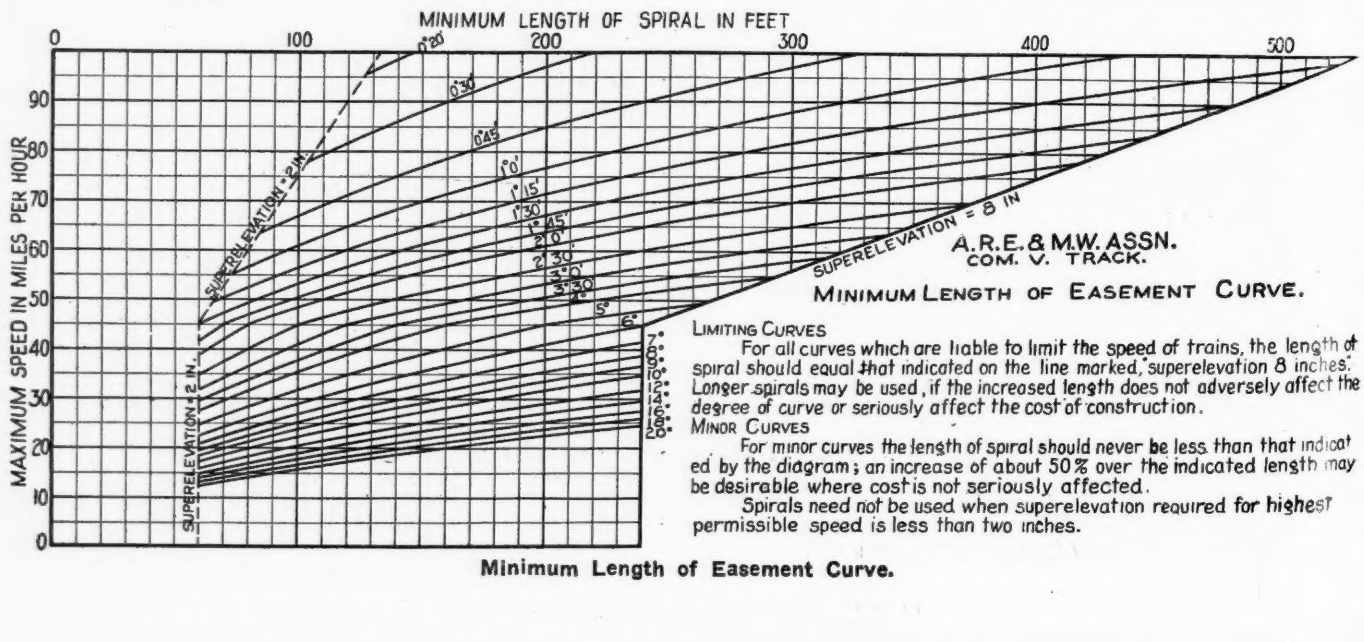
The committee also submitted a diagram indicating graphically the minimum length of easement curve as recommended by the association.

The committee recommends the following changes in the Manual:

Maintenance of Line and Alinement.

(b) Adjustment of curves, with consideration as to easement curves:

Longer easement curves than the minimum lengths rec-



Minimum Length of Easement Curve.

ommended may be used to advantage and often with increased convenience in their application, but any considerable increase in length is wholly unnecessary and should never be made without careful consideration as to the effect on cost. For minor curves, an increase in length of about 50 per cent. over the minimum is recommended when such increase will not seriously affect the cost, nor adversely affect the degree of curve.

The minimum length recommended should be used in all cases where a greater length would adversely affect the degree of curve.

(Following the last paragraph.)

The ten-chord spiral, computed by dividing the spiral into ten equal chords, is recommended. Chords of any length may be used in staking out the ten-chord spiral when the central angle is small. Chords approximating one-tenth the length of spiral should be used when the central angle exceeds fifteen degrees.

Discussion on Track.

Mr. Knickerbocker: In article 3, "Maintenance of Surface," under "Revision of Manual," we wish to have that part of the second paragraph which appears in italics stricken out. The words are: "Speed of trains should be regulated to conform to the maximum elevation used."

In section 2 of the statements on track fastenings with treated ties, we want to insert between the word "rail" and the word "bears" in the second line the two words "does not" so that it will read: "Rail does not bear."

In formula No. 13, under spirals, the T should be T sub S.

In the same portion of the report, the E in the last line of the table of notation should be E sub S.

Under A B in table I, under general instructions for ordering frogs, crossings and switches, the dimensions should be feet instead of inches.

Mr. Lindsay: May not the words "are intended" in the beginning of the 5th section be omitted?

The Chairman: The committee will omit the word "intended."

G. H. Tinker (N. Y. C. & St. L.): It does not seem to me that the first and last paragraphs of the introduction are quite consistent. The last paragraph says that all drawings are to be a part of the specifications. The first paragraph says the manufacturers make the drawings. If the railway company made the drawings, all right. It seems to me that is the proper procedure in any case. Our road makes its own plans, submits them to the manufacturers, and the manufacturers proceed according to the plans, and in that case they are a part of the specifications.

Mr. Knickerbocker: A great many railways cannot afford to make the plans, and these railways ask the manufacturers to submit plans for certain crossings, and they do it. Many railways do not have the opportunity to make these plans, and sometimes they are in a hurry for the crossing and cannot wait to make the plans, and they ask the manufacturers who make the crossings to submit a plan with a proposal for furnishing the crossing, and it is a quick way to obtain a crossing, which you cannot get in any other way.

J. P. Snow (B. & M.): There is a distinction between the first and last paragraph. The first paragraph recites that the manufacturer shall make his own shop drawings, because his shop nomenclature differs from the practice of others, and for this reason he is called upon to make detailed shop drawings. The last paragraph refers to drawings made by the railway company, which may be nothing but a line drawing showing the layout of the crossing.

Mr. Lindsay: In connection with the paragraph on switch rails we will have to take into consideration the drawings which do not show the bend in the stock rail, and therefore are not complete. The web has two faces, and I think it is proper to say that the outer face of the web shall be in a vertical line with the inside edge of the stock rail. It would be better, however, if the words "gage side" were used.

Mr. Knickerbocker: We found in some cases, where the manufacturer did not put in a stock rail, and we had to put that in the track, that the distance from the bend in the stock rail is not uniform. That is matter for consideration another year.

Mr. Lindsay: I move that the committee be instructed to define the bend in the stock rail.

Mr. Rose: If a manufacturer has the point of the switch rail itself given to him, he does not need to know where the stock rail is bent.

Mr. Byers: I move to amend Mr. Lindsay's motion to the effect that the committee be asked to report on this question of the bend of the stock rail as an independent proposition later. Upon vote, amendment to the motion was defeated.

Mr. Rose: If it will satisfy Mr. Lindsay, I think we can add to these drawings the distance from the toe of the switch to the bend in the stock rail as previously figured out by this committee, and that can be readily added to these drawings.

Mr. Lindsay: That is satisfactory.

A motion to insert the words "inner face of the" between the words "between" and "web" was carried.

Mr. Kenly: I would like to ask if the committee has investigated the proposition to make all of the switch rods exactly the same length between the bolt holes and vary the distance from the web to the center of the hole in the lug for the different weights of rail?

Mr. Knickerbocker: We have thought about that a great deal. It would be an advantage for the lugs to be marked.

Mr. Lindsay: I move that in clause 7, the distance of one-eighth inch be increased to one-quarter inch, and that after the words "top of stock rail" there be added "The reinforcing bar shall be bevelled to an angle of 45 deg. where it projects beyond the head of the rail. That is the New York Central practice at the present time. The motion to increase clearance was lost. The committee accepted the insertion suggested by Mr. Lindsay.

B. H. Mann (Mo. Pac.): I would like to know if there would be any objection to changing the sketch of switch point details to show the complete length of the point. Then, if a 16 ft. 6 in. point becomes broken, so that it can be planed down to a point that is 11 ft., all that will be required will be to cut the reinforcing bars, using the same holes for the rivets with the new length and at the same time the interlocking feature will be protected.

Mr. Knickerbocker: We would like to do that but until we can determine whether we can use the same distance from the point to the center of the throw rod of a hand thrown switch as with an interlocked switch, we cannot do it.

W. H. Elliott (N. Y. C. & H. R.): The drilling shown in the diagram is the best from the standpoint of the signal engineer. It provides for the best possible signal construction and enables us to better support the point than we can with the drilling which has been used.

A motion that the committee provide in the plates which go on the two head block ties two holes in each plate of the proper dimension and properly located so that the switch can be spiked when disconnected from the switch-stand or from the interlocking apparatus, was carried.

E. F. Wendt (P. & L. E.): I would not like to see an action taken which would commit the association to a standard which might be used in court against the railway company. The switches as proposed are the very best that could be designed from the standpoint of slide plates and brasses, for illustration. There are few railways in this country, if any, which use switches of this standard, because these switches are of a much higher standard than are now in use in America. You will notice that the tie plates extend two ties beyond the heel of the switch. There may be only one, one or two, or possibly three roads in the country that have a standard of that kind, and while I admit it is the best standard, there certainly can be but very few roads that go that far. If it is necessary to burden the railways with all the expense for additional slide plates and additional braces, let us say so, and then let us advocate the appropriation of the money for the work. We do not spend the money for switches of this standard, however, and I take the position that this extreme number of braces for one point is unnecessary from the standpoint of safety. I am using this point simply by way of illustration, so that we may not commit ourselves to any standard which might be used in a court against the railway companies.

Mr. Patenall: If railroads do not follow improved methods, I am afraid we would get into a bad state of retrogression. However, I do not see that we are taking any great responsibility, in point of law, by applying such improvements as may become necessary, and I believe the committee ought to be sustained in its report.

L. S. Rose (C. C. C. & St. L.): I think if we follow that reasoning to the limit, every action we take would come under the same heading.

Mr. Knickerbocker: Some railways use two tie plates with two spikes and some with three spikes. There are other roads that use the tie plates with a brace on each end. We took the position in our report that we thought was proper. We can not get a general standard to fit all conditions.

H. T. Porter (P. & L. E.): We were not asked to get up a switch that would simply be safe. We could have gotten up one very much similar that would be safe under such reasonable inspection as switches get on a railway, but we did

try to design a switch that would ride smoothly and comfortably, as far as we were able. We also endeavored to design a switch that had the longest possible life. Railways are gradually adding more rail braces to their switches.

W. M. Camp: I think the committee is rather extravagant in the use of rail braces. The object of rail braces at a switch is to take the unusual side thrust of the locomotive or car in taking the switch, and that comes at the point where the track changes direction, and according to my observation it is not usual to have braces all the way to the heel of the switchpoint, especially when rails 33 ft. long are used. I do not see how safety is promoted by having braces back of the rod which comes at the end of the planing. All of the force of the thrust comes against the stock rail on one side and the through rail on the other side when the train takes the switch. That is the part to be protected. It looks more substantial to see braces running back to the heel joint, but I do not consider that it is any safer than to omit, say, half the braces on the 33-ft. side. Two spikes can be put down through the plates which will hold the rail very securely.

A motion to adopt the amended conclusion was lost.

A motion to adopt the recommended drilling of the switch point included in the general instructions for ordering, was carried.

A motion to receive the conclusion as information was carried.

The fourth conclusion was received as information.

Prof. A. N. Talbot: In the report on spirals, I desire to suggest two slight modifications in the table of deflection coefficients. Instead of the word "deflections" in the heading, substitute the words "deflection angles." The table should be changed in form so that the coefficients read down the column for the transit at any given point instead of across the page. This will be very much more convenient for use.

Mr. Cushing: The suggestions are accepted.

Prof. Talbot: In the upper left-hand part of the diagram of minimum length of easement curve is given a limit of length of curve for superelevation of two inches. It will be seen by using these formulas that the amount of throw of track from what it would be for a tangent and circular curve is less than one-quarter inch for all of those opposite that particular dotted line. The last sentence of the printed matter reads: "Spirals need not be used when superelevation required for highest permissible speed is less than two inches." I would suggest the addition of the sentence: "Nor when the distance between the tangent and the parallel tangent of the offset of curve is less than 0.2 ft." I am not anxious about that particular value.

Mr. Jenkins: Taking thirty-minute curves at a speed of about 80 miles an hour, I think a spiral would be preferable there, because it would greatly reduce the shock of contact between the flange of the wheel and the outer rail, and in fact for any lighter curves than one degree at speeds of about 60 miles an hour the same thing would be true. The committee covered that point last year in a discussion of the effect of the very short spiral when the offset was slight and cut that out where the spiral would not govern the path of the wheel at all, but where the spiral would produce any effect on the motion of the train, it was introduced. A great many spirals ought to be introduced in all cases, regardless of how small the offset is. In the answers we received some favored the spirals in all instances and some favored spiral distance of 100 to the foot instead of 0.2. The committee took 0.04 as about the minimum.

Prof. Talbot: I would like to make sure that this association feels that the track can be put down at 0.01 ft., as just mentioned, and that it would pay to put down a spiral where the track would not be shifted from a tangent and circular curve more than 0.02 of a foot, or ¼ in.

A motion to add the sentence suggested by Prof. Talbot was lost.

Mr. Jenkins: For light spirals, it would make very little difference whether we use the formulas derived by Prof. Talbot or Prof. Crandall, or some others. When you come to spirals of high central angle, then the character of the formulas makes considerable difference and there are certain approximations that will apply also to all spirals of small central angle. If you try to make the same formulas apply to spirals for a one degree curve, or a spiral 300 feet long to a one degree curve, and try to make the same formulas apply to a spiral 200 feet long, to a 20 degree curve, the formulas will not apply at all. The track committee has obtained formulas that will apply in all cases up to the practical limit of 45 deg. total central angle.

A motion to express to the committee the thanks of the association for its work was unanimously carried.

MASONRY.

The following sub-committees were appointed:

Revision of Manual: Richard L. Humphrey, A. H. Griffith, G. H. Scribner, Jr.

Waterproofing of masonry, covering methods, results, cost and recommended practice: George H. Tinker, L. N. Edwards, W. J. Backes, F. E. Schall, F. L. Thompson.

Define monolithic construction; revise report on durability of all monolithic construction in arches or large abutments with wing walls: W. H. Petersen, C. W. Boynton, Job Tuthill.

Typical plans of retaining walls and abutments, plain and reinforced, with comparison and recommended practice: T. L. Condron, W. W. Colpitts, B. Douglas, R. T. McMaster.

Investigation and report on the use of reinforced concrete trestles, typical designs and cost: A. N. Talbot, C. H. Moore, G. J. Bell.

Recommendations for next year's work: entire committee.

To co-operate with the joint committee on standard specifications for cement: Howard G. Kelley, C. W. Boynton, C. H. Moore.

To co-operate with the joint committee on concrete and reinforced concrete: C. W. Boynton, L. N. Edwards, A. H. Griffith, F. E. Schall, G. H. Scribner, Jr., F. L. Thompson, Job Tuthill

REVISION OF MANUAL.

Minor changes in wording were made and the following new paragraph was added to the recommended practice for designing reinforced concrete structures:

"Shrinkage and temperature reinforcement: Reinforcement for shrinkage or temperature stresses, in amount generally not less than one-third of 1 per cent., and of a form which will develop a high bond resistance, should be placed and be well distributed near the exposed surface of the concrete."

WATERPROOFING OF MASONRY.

A circular requesting information concerning current practice in the waterproofing of masonry was sent to the members of the association, this circular being substantially a duplicate of circular 122, issued at the request of the committee in 1909. Fifty replies were received, of which 27 contain no information. Some of the replies contain detailed descriptions of structures. An abstract of all replies containing pertinent information is presented with this report. These, together with the replies received last year, are summarized in table I.

The last column contains certain information as to cost. The 1909 replies included very little information upon this subject. It was thought that its publication might lead to unwarranted conclusions. More replies have been received this year, but the conditions are so widely different that hardly any two replies cover the same conditions. Under these circumstances an average cost for any one type of waterproofing would likely be far from the true cost. It is also evident that several of the figures are erroneous, sq. ft. and sq. yd. having been confused, each figure should be considered in connection with the particular example to which it refers.

The masonry structures usually waterproofed are the floors of solid-floor bridges and arches over city streets, to prevent the leakage of ballast water; roofs and walls of subways, to prevent the leakage of ground water; basement and building walls, concrete roofs of buildings and retaining walls, to prevent the leakage of rain or ground water; reservoir and tank walls, to prevent loss by leakage.

The subject of waterproofing may be considered from two points of view. It may be an investigation as to the imperviousness of various substances or it may be an investigation of the methods of treating certain masonry structures so as to prevent the leakage of water through them. The first is a laboratory problem and has not been touched by the committee. The second is a practical problem and is the one considered by the committee. There is involved, in a report upon the condition of a structure from this point of view, the element of suitability to use and also the personal equation of the person making the examination. A reservoir wall may be permitted to leak a few gallons daily; a bridge floor must not allow water to drip; in some situations a stain or discoloration would be objectionable and must not be allowed. Different observers might report compliance with any of these conditions as "perfectly satisfactory." In comparing different methods of waterproofing this element must be eliminated.

Another table was presented, grouping the information

shown in table I in four general classes. Class 1, designated as "exterior envelopes," included all those processes of waterproofing by which the masonry is covered with a thick coating of more or less impervious material, generally applied in several layers and generally including tarred felt or similar fabric or burlap. The waterproofing materials used are coal tar pitch, asphalt or bituminous products of petroleum. Class 1 was further divided into four subheads: "a" including all examples of the use of felt and coal tar pitch; "b" felt and asphalt; "c" burlap and either pitch or asphalt; "d" mastic, this being a bituminous material mixed with sand and concrete and applied in one or more thick layers. Class 2 included examples of materials mixed with concrete. Class 3 was designated as "exterior coatings," and included all those coatings of the nature of washes or paints. Class 4 comprised those examples in which no waterproofing is used.

In class 1, out of a total of 23 examples under subdivision "a" 13 showed no leaks, 2 leaked slightly, and 8 leaked badly; out of a total of 55 examples under subdivision "b" 16 showed no leaks, 9 leaked slightly, and 30 leaked badly; out of a total of 13 examples under subdivision "c" 5 showed no leaks, 4 leaked slightly, and 4 leaked badly; while of the 5 examples under subdivision "d" 1 showed no leaks, 2 leaked slightly and 2 leaked badly. With 8 examples in the second class, 5 showed no leaks, 1 leaked slightly, and 2 leaked badly. In the third class out of a total of 42 cases 6 showed no leaks, 9 leaked slightly, and 27 leaked badly. Out of 4 examples in class 4, where no waterproofing material was used, 1 showed no leaks and 3 leaked slightly.

A study and analysis of the replies indicate:

(1) No method of waterproofing has proved entirely satisfactory.

(2) Some cases are reported in each class showing no leaks.

(3) The difference in efficiency between the various classes does not appear to be great. It does not appear to what extent success is due to the quality of the masonry.

(4) Failures are due to faulty details, poor workmanship, poor materials and the formation of cracks in the masonry.

(5) To secure dry work, it is necessary that details should be carefully designed; this includes the details of the masonry as well as of the waterproofing. The materials must be carefully placed by skilled workmen. The supervision must be constant and efficient. Shrinkage and temperature cracks should be prevented by reinforcement.

(6) Concrete masonry designed and placed as above indicated, with properly designed temperature and shrinkage reinforcement, may be made waterproof without the addition of special waterproofing materials.

TABLE 1.

No.	Character of Structure	Materials Used	Results	Costs
1	Roof of Car Barns	Reinforced against shrinkage	8 leaks in 3 acres; 3 years	
2				
3	Roof and Walls of Subway.	Walls, reinforced against shrinkage	No leaks except at bad joints; 5 years	
		Roof, rock asphalt mastic	No leaks; 5 years	
		Bad work repaired with Wunner's bitumen emulsion	No leaks	
5	Culvert Tops	Medusa compound and truss-con.	No leaks; 1 year	
6	Brick Wall	Mortar mixed with soap and alum	No leaks; 3 years	
7	Reservoir	Crushed dust	No leaks; 3 years	
8	Reservoir, 4	1 Soap and alum and elaterite	No measurable leakage	Two coats soap and alum, 43c per 100 sq. ft.
		3 Soap and alum and asphalt	No measurable leakage	Asphalt, $1.04 per 100 sq. ft.; Elaterite, $1.52 per 100 sq. ft.
9	Arches, Retaining Walls, Bridge Floors	5-ply burlap, pitch and asphalt.	Good results	
10	Arches, Bridge Floors	2-ply burlap and pitch	No leaks; 3 years	Placed by contractors, approximately 20c per sq. ft.
11	Roof of Magazine	Rich mortar plastering	Not perfect	
12	Bridge Floor	6-ply felt and pitch	No leaks except along webs of girders	Approximately 6c per sq. ft.
	Bridge Floor	1-2 mortar	Just as good; 2 years	
13	Bridge Floor	Sarco and burlap	Good	About 8c to 38c per sq. ft.
14	Bridge Floor	4 or 5 ply felt and pitch or asphalt	Few leaks; 8 bridges, 2 leak, 6 O. K.	About 5c per sq. ft.; protection over waterproofing, about 7½c per sq. ft.
15	Bridge Floor	Sarco and burlap	One leak	15c per sq. ft.
16	Bridge Floor	Asphalt	Some leaks around rail joints	24c per sq. ft., including labor and material.
17	Trough Bridge Floor Masonry Arch	5-ply felt and asphalt	Practically water-tight	9.1c per sq. ft.
		Young's mixture	No leaks	Chemical cost, $290.85; Concrete, including chemical cost, $10.23 per cu. yd. or 6.3c per sq. ft.
18	Bridge Floor Concrete Arch	Mastic	9 bridges; 2 tight, few leaks in 7	Natural rock asphalt mastic, 45c per sq. ft.; Hydrex felt, with brick, 25c per sq. ft.; positive Seal felt, 23c per sq. ft.; Special asphalt mastic, 30c per sq. ft.
		5-ply felt and asphalt	9 bridges; 2 tight, few leaks in 7	Natural rock asphalt mastic, 45c per sq. ft.; Hydrex felt, with brick, 25c per sq. ft.; positive Seal felt, 23c per sq. ft.; Special asphalt mastic, 30c per sq. ft.
19	Retaining Walls	Asphalt paint	Can be scraped off	
		Cement and coal tar	Penetrates	
	Bridge Floors	Felt and pitch	Difficult to handle, abandoned	
		Mastic	Cracked, abandoned	
		3-ply burlaps saturated with asphalt	Good results, expensive	
		3-ply plain burlap, asphalt and mastic	Few leaks; tore over columns	About 16c per sq. ft.
20	Masonry Arches with Concrete Backing Cellar Wall	Young's mixture	Leaks	
		Sarco mixture	O. K., 1 year	15c per sq. ft., including material, tools and labor.
		Young's mixture	Failed } N. B.—Conditions different	
		Winslow's compound	O. K. 18 mos. }	
21	Stone and Brick Arch	Tar paper and pitch	Leaked badly; waterproofing cracked; 1 year	
		4-ply felt and asphalt	No leaks; 4 years	40c per sq. ft.
	Reinforced Concrete Arch	Anti-hydrine damp-proofing	Leaked badly	
		4-ply felt, asphalt and brick	No leaks; 2 years	31½c per sq. ft.
	Reinforced Concrete Arch	Cerian paint and ½-inch asphalt	No leaks	
	Reinforced Concrete Arch	Cerian paint and 1-inch asphalt.	No leaks; 5 years	10c per sq. ft.
	Bridge Floor-plate	2-ply felt, 1 burlap and mastic	Leaks along webs of girders	
	Bridge Floor-plate	Hydrex felt	Small leaks over columns; 1 year	
	Bridge Floor-trough	Asphalt concrete and ½-inch mastic	No leaks in waterproofing	
22	Cellar	3-ply tar paper and asphalt	No leaks; 3 years	About 6c per sq. ft.
23	Concrete Wall	3-ply Barrett felt and asphalt	No leaks; 3 months	5.8c per sq. ft.

TABLE NO. 1—Continued.

No.	Character of Structure	Materials Used	Results	Costs
24	Subway—Plate Roof	5-ply felt and asphalt; also red lead paste and brick in asphalt on roof	No leaks; 6 years	
25	Basement	6-ply felt and pitch	No leaks; 6 years	5c per sq. ft. for 3-ply; 10c per sq. ft. for 6-ply; contract price.
26	Retaining Walls	⅛-inch pitch	Fairly satisfactory	3.18c per sq. ft.
	Dust Line	3-ply tar paper and pitch	Unsuccessful; expansion causes cracks	5.91c per sq. ft.
	Subway Walls	4-ply felt and pitch; hollow tile.	No leaks	Hollow tile, 18.5c; waterproofing, 5c per sq. ft.; total, 23.5c per sq. ft.
	Roof—Concrete Arches	3-ply felt and pitch; brick	No leaks	Waterproofing, 3.82c per sq. ft.; brick protection, 9c per sq. ft.; total, 12.82c per sq. ft.
27	Trough Bridge Floor	Iron bark	Failed	
		5-ply Hydrex, 3 tracks	1 dry, 2 leak; 2 years	95c per sq. yd.
		4-ply Barrett, 2 tracks	1 dry, 1 leaks; 4 years	16½c per sq. yd.
		Iron bark, 2 tracks	No leaks; 4 years	
		5-ply Hydrex, 1 track	No leaks; 3 years	
		4-ply Barrett, 1 track	Leaks badly; 3 years	
		Iron bark, 1 track	Failed; 1 year	
		5-ply Hydrex, 1 track	Leaks badly; 2 years	
		5-ply Hydrex, 3 tracks	Leak badly; 3 years	
		4-ply Barrett, 1 track	Leaks badly; 3 years	
		Iron bark, 1 track	Failed; 1 year	
		5-ply Hydrex, 1 track	Leaks badly; 2 years	
		Iron bark, 5 tracks	Removed; 1 year	
		5-ply Hydrex, 5 tracks	Leak badly; 2 years	
		5-ply Hydrex, 1 track	Leaks badly; 3 years	
		4-ply Hydrex, 1 track	Leaks badly; 3 years	71½c per sq. yd.
		4-ply Barrett, 2 tracks	Leak badly; 3 years	
		3-ply Hydrex, driveway	Leaks badly; 3 years	57c per sq. yd.
		4-ply Hydrex, 3 tracks	2 dry, 1 leaks; 3 years	
		4-ply Barrett, 1 track	Leaks badly; 3 years	
		Iron bark, 1 track	Removed; 1 year	
		5-ply Hydrex, 1 track		
		Iron bark, 5 tracks	Removed; 1 year	
		5-ply Hydrex, 5 tracks	Leak badly; 2 years	
		4-ply Hydrex, 3 tracks	Leak badly; 3 years	
		4-ply Barrett, 1 track	Leaks badly; 3 years	
		3-ply Hydrex, driveway	Leaks badly; 3 years	
		6-ply Barrett, 1 track	No leaks; 3 years	24½c per sq. yd.
		4-ply Barrett, 1 track	Leaks badly; 3 years	
		4-ply Hydrex, 2 tracks	Leak badly; 3 years	
		Iron bark, 1 track	Removed; 1 year	
		5-ply Hydrex, 1 track	Removed; 1 year	
		Iron bark, 5 tracks	Removed; 1 year	
		5-ply Hydrex, 5 tracks	2 dry, 2 leak, 1 leaks badly; 2 years	
		4-ply Hydrex, 2 tracks	1 dry, 1 leaks	
		4-ply Barrett, 2 tracks	No leaks	
		6-ply Barrett, 1 track	No leaks; 3 years	
		4-ply Hydrex, 2 tracks	1 dry, 1 leaks badly; 3 years	
		Iron bark, 2 tracks	Removed; 1 year	
		5-ply Hydrex, 2 tracks	1 dry, 1 leaks	
		6-ply Barrett's, brick protection.	No leaks; 1 month	13.2c per sq. ft.
		5-ply Hydrex	1 leak; 1 year	95c per sq. yd., including material, tools and labor.
28	Plate Floor	Pitch	Leaks through boltholes	
	Train Shed Floor	Mastic	Cracked and leaks	
29	Concrete Slab; Bridge Floor	5-ply felt, 1 burlap and pitch	No leaks; 15 months	15½c per sq. ft., including 10 year guaranty.
31	Floor Slabs	3-ply burlap, Sarco	....	Floor slabs, L. 7.7c, M. 12.5c per sq. ft.; back of walls, L. 1.0c, M. 1.0c per sq. ft.
32	Floor Slabs	Mortar, pitch	No leaks	Between 40c and 50c per sq. ft.
33	Floor Slabs	Felt and pitch	Small leaks; 2 years	Maximum cost, about 30c per sq. ft.
34	Block and Tile Wall	Elaterite	Cracked and curled up; 1 year	M. $1.00, L. 10c per 100 sq. ft.
		Bay State cement coating	Wore off; 1 year	M. $2.60, L. 30c per 100 sq. ft.
		Coal tar and cement	....	M. 10c, L. 10c per 100 sq. ft.
35	Bridge Floors	Asphalt mastic	Leaks along girders; mastic cracks	15½c per sq. ft. in place.
36	Masonry Arch	Asphalt	Prolonged life 10 years	15c per sq. ft., including removal of fill and supporting of tracks during work.
37	Subway	Asphalt, felt, burlap, Sarco, brick	Bottom and sides, 1 leak per 100 sq. ft.	13c per sq. yd., including brick encasing.
		Hydrolithic cement	Roof leaks a little; 2 years	
38	Cellar	5-ply Barrett's	No leaks; 1 year	About 12c per sq. ft. labor and material.
39	Bridge Floors	Felt	No leaks	
		Mastic	3 out of 7 bridges show leaks along girders	
41	Reservoir	Asphalt	Good results	
43	Bridge Floor	4-ply felt and slag on matched flooring	Many leaks	About 8c per sq. ft. for felt and slag only; done under traffic.
45	Bridge Floor	Barrett's	No leaks; 4 months	
46	Reservoir	Medusa	Reduced leakage; 1 month	15c per sq. yd.
47	Bridge Floors	Pitch on matched flooring	Failed after about 5 years	
		4-ply burlap and elaterite on creosoted plank	Failed second winter	60c per sq. ft.
48	Bridge Floors	1-ply burlap and Sarco	4 bridges, no leaks; 1 bridge leaks slightly; 1 year	11.4c per sq. ft.

Note—Numbers in the first column refer to the abstracts of replies having the corresponding numbers, which should be read in connection with the table.

*Nos. 1 to 20 refer to abstracts published in Bulletin 119 and in the Proceedings of the 1910 Convention.

MONOLITHIC CONSTRUCTION.

Monolith of Concrete.—A singles mass of concrete made without joints by a continuous operation of construction.

Monolithic concrete construction is the building of a single mass of concrete without joints by a continuous operation.

In order to judge of the merits of monolithic construction we should examine the various causes which bring about the failure of masonry construction to ascertain whether or not monolithic construction will either prevent or delay failure when masonry is subjected to conditions that are likely to occur during their lifetime.

Below are given causes for various masonry failures as taken from reports of various railroads, and a report by

Prof. Swain, which was gathered from various periodicals for the use of the committee:

(1) Faulty Design: (a) Where masonry is placed on grillage above the water line, the grillage rotting and allowing masonry to settle. (b) Where grillage rests on piling and where the designer used too high a unit stress for timbers in compression. (c) Where U-abutments have their wings built too light. (d) Where the designer has allowed too high a unit pressure on the earth in front of the abutment or on piling upon which it may rest. (e) Settlement which frequently causes a crack to appear where the wing leaves the main portion of the abutment. (f) In case of arches, the wings sometimes separate from the body of the arch or the arch will frequently crack from 10 to 20 ft. on each side of the center line of the track, depending upon the height of the fill. (g) Lack of proper drainage.

(2) Poor material or poor workmanship.

(3) Temperature cracks.

(4) Disintegration of the masonry: (a) On account of the freezing and thawing of exposed surfaces of masonry, particularly where water drips through an arch ring or where the masonry near the ground is exposed to alternate freezing and thawing. (b) On account of masonry being exposed to salt water, alkalies, acids or heat.

(5) Improper filling.

(6) Scouring Away of the Material Underneath the Masonry: (a) On account of unusual freshets. (b) On account of driftwood, wagon bridges, etc., lodging against the masonry. (c) Account of ice gorges. (d) Account of the size of the opening being too small, which causes the water to rise during a freshet and which increases the velocity of the stream sufficient to scour away the material underneath the masonry.

(7) Material sliding and carrying the masonry with it.

Cause 1.—If the settlement in cases (a), (b), and (d) was not uniform in a large monolithic structure they would probably crack unless they were reinforced so as to prevent settlement cracks. If the structure was an ordinary single-track abutment up to about 20 or 25 ft. in height it would probably settle without cracking. If the abutments were built in sections the different sections would be divided in a vertical plane and prevent unsightly cracks.

In the case of arches under high fills and on ordinary soils it is difficult to prevent cracking of the arch abutment and ring unless reinforcement is used, on account of the pressure on the foundation in the center of the arch being very great when compared with the pressure at the end of the wing walls. The monolithic character of the arch abutment and the arch ring are not strong enough to distribute the load uniformly over the foundation, and when a slight settlement occurs in the center it causes cracks that are unsightly but seldom dangerous.

Cause 3.—Several railroads reported temperature cracks in their abutments, while other roads reported abutments built of plain concrete in lengths of from 60 to 100 ft. without cracking, and when the abutment was reinforced in lengths of 150 ft. without cracking. There is evidently a wide difference of opinion as to the effect of changes of temperature on large monolithic structures. The front of the abutment has no forces to prevent its free contraction and expansion on the back, side and bottom of the abutment; however, the concrete contracts and expands more than the material adjoining it and hence when the movement occurs the structure must be strong enough to overcome the friction between it and the adjoining material, or crack.

Causes 5 and 7.—A monolithic structure well designed will resist failure from both of the causes better than an abutment built in sections.

Cause 6.—In designing waterway openings the size of the opening is selected to take care of the maximum amount of water that is likely to come to the opening. It frequently happens that the amount of water has been underestimated or that the opening has been blocked by driftwood, ice gorges or other material which has induced scour in the bed of the stream or raised the high-water mark, or both. When the scour line is below the foundations of the abutments they are apt to move and tip forward or settle bodily downward. When this happens a monolithic abutment will resist the pressure back of it better than one built in sections, because when one portion of the abutment is undermined the balance of the abutment will assist in preventing failure, and, even if the abutment does tip forward, the movement at times is slow, and failure can be prevented by relieving the pressure at the back or putting in props across the bridge opening.

In building abutments for subways it is frequently impracticable to build them as a single monolith, and, even if it were practicable, the abutment when underneath a number of tracks would be long, not very high and any slight settlement would cause an unsightly crack. The abutment would be in a prominent place, where any crack would be observed by the general public and create unfavorable comment.

Again, when abutments are built in horizontal layers and the work is not done continuously, wherever the work has been stopped long enough to allow the lower portion to set before placing the upper portion a seam has been found in the concrete, and when the back filling has been made and become saturated with water the water will pass through the concrete through this seam. In city work this seepage is unsightly, it will form ice on the sidewalks in the wintertime and the action of the frost will disintegrate the concrete. For these reasons it is desirable that when abutments are built in sections they be built of such length that each section can be built continuously.

Conclusions: These conclusions are based upon the supposition that the structure is well designed and that the foundation is good:

(1) That monolithic concrete construction may be used without danger of cracking for abutments of any length that the working conditions will permit, provided the length does not exceed about three times the height.

(2) That where abutments with wing walls are not of monolithic construction, joints should be provided at the intersections of the wing walls and the body of the abutments.

(3) That reinforced concrete abutments may be built in units of any length that economic conditions will permit.

(4) That monolithic concrete construction may be used for arches where the conditions will permit, otherwise the arch ring should be constructed with radial joints.

RETAINING WALLS AND ABUTMENTS.

The committee reports progress and suggests that the work be reassigned.

REINFORCED CONCRETE TRESTLES.

Through the secretary, a circular letter was sent out on October 26 to a large number of railroads, asking for the extent of the use of reinforced concrete trestles, the length of time they had been in service, their present condition and apparent durability and the approximate cost for ordinary conditions. Forty-six replies to this letter have been received. The C. M. & St. P., C. B. & Q., C. R. I. & P. and N. P. railways have built such trestles, while the G. N. and C. G. W. railways have made plans for similar structures. The other replies state that the roads have not used this type of construction, though a number of them use decks of reinforced concrete and structures built in places.

In view of the limited time this form of structure has been in use, it does not seem best to present typical plans for reinforced concrete trestles at this time.

The report is signed by: W. H. Petersen (C. R. I. & P.), chairman; G. H. Tinker (N. Y. C. & St. L.), vice-chairman; W. J. Backes (Cent. N. E.); G. J. Bell (A. T. & S. F.); C. W. Boynton (Univ. Port. Cem. Co.); W. W. Colpitts (K. C. M. & O.); T. L. Condron, consulting engineer, Chicago; B. Douglas (Detroit River Tunnel Co.); L. N. Edwards (Grand Trunk); A. H. Griffith (B. & O.); Richard L. Humphrey, consulting engineer, Philadelphia; Howard G. Kelley (Grand Trunk); R. T. McMaster (P. & L. E.); C. H. Moore (Erie); F. E. Schall (L. V.); G. H. Scribner, contracting engineer, Chicago; A. N. Talbot, professor municipal and sanitary engineering University of Illinois; F. L. Thompson (Ill. Cent.); Job Tuthill (C. H. &. D.).

Discussion on Masonry.

The recommendations for revision of the manual were accepted with very little discussion.

The definitions of monolithic construction, and the conclusions of the committee for publication in the Manual were accepted.

Mr. Steffens: In the matter headed, "Investigate and report on the use of reinforced concrete trestles, typical designs and cost," there is mentioned particularly the flat slab trestle construction, which has been used so extensively by the roads in Chicago. The Southern railway has built another type of flat slab trestle in North Carolina, a trestle of girder construction, of reinforced concrete, and it might be well for the committee to see if plans can not be obtained and a note made in the proceedings.

Mr. Loweth: We have been building something that is

closely akin to a concrete trestle for a good many years, in the form of reinforced culvert tops. The concrete trestle in one way is a larger development of the reinforced concrete culvert tops. We have gone into it quite extensively and so far as our experience goes it will warrant a more extensive use. We find that the cost, speaking generally, is about thirty dollars a foot, sometimes a little less and sometimes a little more, depending on the question of the amount of the work and the difficulties under which it is prosecuted. Sometimes we are able to build the slabs under traffic, but that is not often the case—more usually they have to be made on one side and moved in, or built some distance from the bridge and taken to the bridge and put in. We feel that in many cases there is a field of usefulness for the concrete trestle and that it gives a permanent construction at a cost much less than steel construction. We have in many cases steel spans of greater or less length crossing the main channel, and the approaches to the spans over flats that are subject to overflow only are of concrete trestle type construction. We have used spans up to eighteen feet; the standard being about 15 ft. 6 in. or 16 ft. We have to be careful to use them only in the places where we can use comparatively short spans. Lately there has been more or less apprehension concerning our timber bridges, due to fire caused by cinders dropping from the locomotives. When we get the new ash pan required by law and the concrete trestle we will get away from that danger. Of course, the same thing would be accomplished with a creosoted timber and ballasted floor and while we have used considerable of that type of construction, yet it does not afford the permanency we expect to get out of the concrete.

A. S. Baldwin: There is a suggestion I would like to make, arising from Mr. Loweth's remarks, with reference to the use of creosoted trestles; that is, in a comparison of the two methods of construction it is very important that the liability of the creosoted trestle to take fire should be considered. Our losses during the last year from fires in connection with creosoted trestles have been very heavy. We have had several thousand feet of these trestles burn.

The President: Open deck or ballasted floor.

Mr. Baldwin: Ballasted floor decks. In some cases we have not been able to trace the exact cause of those fires. Investigations show that as a general thing when you capitalize the cost of a creosoted structure, it does not, compare favorably with the concrete structure. At the same time, I believe if reliable statistics could be obtained as to the amount of loss in creosoted structures by fire, that the results would be very different, and we are now endeavoring to get some actual data as to that.

Mr. Loweth: There is an illustration in the report of some of our designs for concrete trestles, but in the light of the experience we have had, we are going to make some modifications. They will be quite minor, but som modifications will be made. We shall probably put a metal plate between the slab and the top of the pier, so as to make a greater resistance in the top of the pier against any slight movement in the slab.

Mr. Smith: I have looked into the question of reenforced concrete trestles, and I have not found where we would be justified in adopting them. Our trestles cost us about $8.00 a running foot, our maintenance about 75 cents per foot, our fire losses about 5 cent per foot. The interest, at 5 per cent on $8.00 per foot, is 40 cents, making a total of $1.20 for the timber trestle. As against that, the reenforced concrete trestle costs $30 per foot, would have an interest charge of $1.50, to which we would add 20 cents per foot for track maintenances, which would be $1.70 or approximately a difference of 50 cents per foot increased cost for the concrete trestle. We have about 155 miles of timber trestles, or 800,000 lineal feet. Of that number, 300,000 feet will ultimately be disposed of, either by filling or by replacement by steel structures. The other 500,000 feet at 50 cents per foot, would increase the cost to the railroad company, $250,000 per year, if we were to adopt reenforced concrete trestles.

W. L. Seddon, (Seaboard A. L.): I would like to ask whether there has been any other experience of fire losses as suggested by Mr. Baldwin. We have not used creosoted trestles long enough to get any data on that, but I hadn't expected a very great amount of loss from creosoted trestles. Creosoted telephone poles went through the fire at Jacksonville, Fla., and were the only things of wood that stood that fire.

Mr. Baldwin: Our experience shows that there is less danger of a creosoted piece of timber catching fire than of a piece of old defective timber. A spark on a piece of defective timber will start fire very rapidly, whereas if it comes against a sound piece of creosoted timber, it does not light, and does not take fire readily; but after the fire starts in those structures, it is so fierce as to be almost uncontrollable. That is the case with creosoted ties that have been placed along the right of way. I do not think they catch quite as readily as other timber. They certainly do not catch as readily as old timbers, but after they start, you cannot do anything with them, the fire is so fierce and the heat is so intense, it is impossible to control the fire.

Mr. Seddon: Has your loss been from fires originating on the right of way?

Mr. Baldwin: In one case the loss was from an adjoining structure. In several other cases we have not been able to find out what was the cause of it.

Mr. Seddon: I examined the poles at Jacksonville after the fire there and they seemed to be charred about an eighth of an inch, and then the fire seemed to have choked itself.

The President: I think there is a general theory that after the lighted oil evaporates from the surface the chance of creosoted material catching fire is remote.

Mr. Smith: We have kept a good record of our fire losses for about two years and we have found that about 95 per cent. of the fires start on top. A good many start from cinders that drop down. A good many of them could be averted by covering the deck with galvanized sheet iron. I understand some roads have used galvanized sheet iron on top of the stringers, which would prevent the stringers catching fire. By placing galvanized iron on top of the ties, at the end of the bridge, over the back walls, the fires would be eliminated.

Mr. Loweth: Last year the St. Paul company fireproofed the timber decks of about en miles of bridges, and we shall probably do as much more this year. That is an added expense, not only for the cost of first construction of the fireproofing, but because it makes the future maintenance of the bridge and the inspection of the bridge more expensive. However, it is forced upon us because there seems to be an increasing danger of fire to timber bridge floors on account of the changes in the locomotive fireboxes which have recently been brought about. All of the timber bridge floors on the coast extension of the St. Paul road are fireproofed from one end to the other, and I feel that we will eventually have to come to protection of that kind on practically all of our timber floors; perhaps not for timber floors on steel structures, but certainly for timber floors where the ties are of timber resting upon timber stringers. Our practice has been to carry the metal protection clear across the full length of the bridge, and at first I tried to eliminate it between the rails, but found that that did not give the full measure of safety, and it was necessary to carry the protection out to and over the outer guard timber. In a great many cases we have put in gravel protection. We are trying out both methods. The gravel protection consists in putting in board strips between the tops, blocking them up above the stringers, and then putting gravel on top of the ties and the board strips. It takes, however, a pretty coarse gravel. In some cases we could not get the gravel that was suitable and we used crushed stone. There is some difficulty, of course, in maintaining the gravel, because the tendency is for it to work to one side or the other. I believe if we compare the cost of an ordinary pile of timber structure with any other prominent type of construction that we must take into consideration the cost of fireproofing timber structures. We have not been able to justify on the score of economy alone the large use which we have made of reenforced concrete trestles, or even creosoted ballast trestles; but I think that we must concede something for better construction, even if it is not economy.

Mr. Smith: We have recently been offered by the mechanical department a lot of scrapped car roofing, which we figure can be applied to our old trestles at a cost of 10 cents per running foot, which is practically no increase in cost. The stringers in our trestles last us eight to twelve years; in the south a relatively shorter period, perhaps eight years.

Mr. McDonald: We have been using galvanized iron as protection for stringers and caps for ten years. We have had a great deal of difficulty in keeping galvanized iron on the stringers. It has a tendency to creep. The cause of creeping we have been unable to determine absolutely, but we have discovered measures that we can depend upon. I have discovered that pine stringers, which have been well covered for ten years, have been in good condition, as good as they were when they were put in. Our fire losses last year on trestle work, out of a total of 7 miles, amounted to 24 lineal feet. Those trestles are all decked. My attention was first called to the question of protecting stringers with galvanized iron by noticing the experience of the Cincinnati Southern.

They had a lot of stringers that were put in in 1871. I had occasion to examine them after they were taken out, in 1889, and notwithstanding the fact that the galvanized iron had not been taken care of, had been permitted to be perforated, and other things, wherever that iron remained over the stringers, those stringers showed almost no rot whatever. They were made of white pine. I find that it costs us 50 cents a lineal foot of trestle to cover, in a very elaborate way, our stringers and caps. A red oak or gum cap can be made to last ten or fifteen years. Ordinary galvanized iron, bought in the open market, when applied to trestle work, will last on some branch lines five or six years, and on the main line, where sand is dropped from the locomotive, it lasts only about three years. Recent experiments have justified us in the adoption of the modern pure iron, as it is called, and we think we are going to get at least an average of seven years life out of that metal, and I expect to fully realize twenty years life out of the timber by that method of protection.

THE ANNUAL DINNER.

The annual dinner of the American Railway Engineering and Maintenance of Way Association was given in the gold room of the Congress hotel last night. President Fritch of the association, was toastmaster. While the dinner was in progress the diners sang a number of songs which had been written for the occasion. Most of them were printed on a pink sheet entitled "Maintenance of Way Extra," but which was generally referred to as the "Sporting Extra." Subsequently, a green "Double Extra," came out containing the story in song of the "Brownsville Trestle," a tale attributed to Frank R. Coates.

The first speaker was S. M. Felton, president of the Chicago Great Western, whose subject was "Economy and efficiency on Railways." The speeches were as follows:

President Fritch.

We are assembled tonight to celebrate the twelfth annual convention of the American Railway Engineering & Maintenance of Way Association. It may be well to state here that on account of the pressure brought upon the railways tc enforce economies we have decided, as in other matters, to set the pace and economize by changing the name of our Association to the American Railway Engineering Association. (Applause.) A reduction of just exactly 50 per cent, which is true economy.

We have an interesting program before us tonight, and in addition to the prominent speakers who are to address you, the committee on arrangements has provided some surprise entertainments, which will either condemn or commend them, and we will reserve our judgment until the entertainment has been rendered.

The rehabiliation of the railways has been the most wonderful development in our modern industrial age. The original lines of the most important railways in this country have been almost entirely rebuilt, and in many instances several times. This has been brought about in order to meet the ever increasing demands upon transportation, and the ever decreasing returns for its performance. There is no man in our country today who has taken a more prominent part in this work than our first speaker, who is justly entitled to the term: "R. R. D." or doctor of railways, if such a term could be invented.

S. M. Felton.

When I was asked to speak at the dinner of your association this evening, I expected to be able to find sufficient time to prepare an address on the subject of efficiency and economy of railways that would be more complete than the few remarks I am about to make. Unfortunately, other pressing matters have prevented my treating the subject as exhaustively as it deserves.

The recent decision of the Interstate Commerce Commission in denying to the railways the right to advance their rates, is said, in a great measure, to have been influenced by the plea that the roads were not economically and efficiently managed. The statement has been made, as you are all doubtless aware, that a sum of one million dollars per day might be saved if scientific management was inaugurated. This amount would represent a reduction of 21½ per cent. in all operating expenses and an amount equivalent to the entire item of maintenance of equipment expenses, where it was claimed the principal saving could be made.

There are ways and means in the railway service, as in all other lines of industry, to effect economy and promote efficiency by the application of scientific methods and principles. That they are in effect at the present time in the operation of railways is too well known by gentlemen like you, who have been responsible for many of the economies already effected.

The maintenance of way and structures of our railways call for an annual expenditure of approximately three hundred millions of dollars, every dollar of which is expended with intelligence, honesty and effectiveness. Proof of this fact is evident from the good physical condition of our railway properties. It is not claimed that perfection has been reached by any means, in the application of sound engineering principles in the construction and maintenance of our railways, but that the advance made in the application of scientific principles, economical methods and high grade of efficiency have been applied to a greater extent in the engineering departments of our railways than in any other industrial activities.

The very object of your association is "advancement and knowledge pertaining to the scientific and economic location, construction, operation and maintenance of railways." That this has been most assiduously and earnestly followed is evidenced by the splendid work which you have done. No railway organization, considering the time your association has been in existence, has accomplished as large an amount of work and obtained as good results as the Maintenance of Way Association, and it is through its work that the railways must largely look for the more economic and efficient performance of their operations.

The rehabilitation of the railways of America is a monument to the ability of the engineering profession. There is scarcely an important railway in this country which has not been practically rebuilt within the past twenty years. Millions of dollars have been expended to carry on this work and the economics effected thereby have been justified almost without exception by the reduced cost of transportation which is immediately transferred to the benefit of the public in the form of reduced rates, greater facilities and improved service.

The capitalization of railways in the United States as compared with other countries is greatly in our favor. As an illustration: The cost of construction of the English railways is placed at approximately six billion, four hundred million dollars, and the cost of the railways in the United States at thirteen billion, five hundred million, or the English railways have in the ratio of one-tenth the mileage at one-half the cost of our railways. Carrying the comparison a little further, the service of the American railways is less than that of any other country in the world, save a few small countries having a limited mileage and inferior railways. In 1908 the average receipts per ton mile for freight transportation in England were 2⅓ cents, while in the United States they were ¾ of a cent, or less than one-third.

The ability of American railways to furnish the best service at the lowest rates is largely due to the efforts of the engineering profession which has evolved economies in the form of grade reduction, curve elimination, improvements in track and other structures, which have greatly reduced the cost of maintenance of property.

This work in the past twenty years has contributed largely to the increase in the average net tonnage per train, which raised it from 176 to 388 tons, or 116 per cent.

The committee on rail is performing most excellent service in the studies which are being carried on to perfect a set

of specifications which shall give to the railways a "good steel rail." The public generally little appreciates the amount of time and earnest thought that is being given to the various problems entering into the operation of railways. The work of the engineer is done quietly and without display. He does not sound his trumpet but works quietly in the laboratory and work shop and his reward comes in the satisfaction of work well done.

Economies which are being effected in the preservation of ties and timber used in railway construction will soon show their effect upon the expenses of operation. One of the largest items of the expense of maintenance of track is the renewal of cross ties. The annual requirements of American railways on this item alone are from 125 to 130 million ties. Your association has accomplished a splendid work along the lines of conservation of our natural resources by practically increasing the life of our ties from an average of about seven years to from 15 to 20 years. The economies in the way of reduction in maintenance of ties will be effective some years in the future, or after the treated ties have outlived the average untreated tie. A like economy has been effected in the use of treated timber in the construction of bridges and trestles, which has resulted in the increase of the life of the structures of from 100 to 200 per cent.

During the early period of railway building, the use of masonry and steel in the construction of bridges and trestles was very limited, largely due to the high cost and to the light unit loads of equipment used. As the traffic increased and the weight of locomotives and cars increased, it has been necessary on many lines to renew wooden structures every ten years. The introduction of masonry and steel and the use of concrete in bridge construction has been one of the most interesting developments in the maintenance of our railways. The economies effected in the use of the latter material have been applied in railway operation perhaps to a greater extent than in any other one line of industry. Your association has done a valuable work in its technical investigation of the stresses and strains due to impact on our bridge structures, the actual tests having been made under careful observation with trained, skilled men. The result of these investigations will prove of great economy in bridge design and construction.

In building construction the engineering departments of our railways have devised many methods for economical and efficient operation. The development of the modern coaling station has reduced the cost of handling coal for locomotive use from the cumbersome methods of twenty years ago, when it cost from 15 to 20 cents a ton, down to one or two cents per ton. Maintenance of way work has been made more effective and economical through the introduction of labor saving devices, such as power hand cars, the use of power drills, ditching machines, track laying machines, modern derricks and pile drivers and a superior quality of track tools. The methods of carrying on the work today, in contrast to the crude method of former years, are systematized and intelligently directed and conducted, all of which has resulted in producing economies. These methods apply to the laying of rail, placing of ties, ballast, installing frogs and switches, cleaning right of way, erection of bridges and trestles, the general maintenance of line and surfacing of tracks and other operations having to do with the maintenance of the roadbed and track.

There is, however, one item in the cost of operation of railways that should be largely reduced, and that is the item of taxes and assessments. Unfortunately, this matter is entirely beyond the control of the railways, but lies within the power of authority which likewise prescribes the limit of its revenue.

The reports of the Interstate Commerce Commission show that the total amount of taxes and assessments paid by the railways of the United States for the year ended June 30, 1909, was $90,333,559, or at the rate of $401 per mile of line. In 1889, twenty years ago, the total taxes paid were $27,590,394, or $179 per mile, an increase of $62,743,165, or 227 per cent., being $222, or 124 per cent. per mile of line. The net capitalization per mile of line in 1889 was $48,021, and in 1909, $57,962, an increase of 20.7 per cent. Therefore, taxes per mile of line increased six times as much as net capitalization.

The inequality of taxes levied upon railway property as compared with other corporate and private property is most unjust and in all fairness requires a correction.

A recent investigation in the revenue system of one of our largest states revealed a condition of affairs which shows the extent to which railways are being overtaxed and other corporate and private property undertaxed. In other words, the railways are paying the taxes that are justly due from other corporations and private property.

A just basis of taxation is that every dollar of property be taxed alike, whether it be railway, other corporate or private property. In the state referred to the railway property is assessed at its true value, while other property is assessed at an average of 46 per cent. of its true value. The proportion of corporate property, including railway, in the state is 16 per cent., while private property is 84 per cent. The proportion of taxes paid by corporations (including railways) is 55 per cent., while private property paid but 45 per cent. In other words, corporations owning less than one-sixth of the property paid over one-half of the taxes, while private owners with over five-sixths of the property paid less than one-half the taxes.

The amount of taxes paid on investment of $10,000 in railway property was $19.20, while the same investment in private property paid only $9.20, or less than one-half.

This state places three sets of valuations upon railway property, namely:

First, by the railroad commission for the purpose of regulating the issue of securities and rates, at $210,000,000; second, by the tax commission for the purpose of taxation, $409,700,000; third, by the local assessors, at $330,000,000.

The investigating committee which developed these facts very properly concluded that, "A merchant who would have three yardsticks in the regular course of his business would have trouble with the grand jury, and the state should certainly practice the same standard of honesty that it requires of its citizens."

It is likely that a comparatively similar condition prevails in other states of the Union and that the railways are generally greatly overtaxed and are bearing the burden of taxation of private owners whose very property has been enhanced in value by the construction of the railways.

A fruitful field is open for a committee on efficiency and economy, to see that railways pay only their just proportion of taxes and assessments, and no more.

It must be remembered that the operation of railways is unlike that of any other branch of industrial activity. In the majority of commercial industries the operations are confined to narrow and prescribed limits and every detail can be closely supervised and instantly corrected, if found faulty. On railways the operations extend over thousands of miles and authority must be delegated to men not constantly under the watchful supervision of a trained authority. A certain amount of waste under such conditions is almost inevitable and it requires constant vigilence and untiring energy to produce the results obtained.

While much has been done in the past in the way of establishing a high grade of efficiency, in the operation of railways, much yet remains to be done. The evolution in railway service is rapid. New problems are constantly arising and the ever decreasing rates of transportation enforce the application of scientific methods which will reduce the unit cost of transportation to the lowest possible point. Much responsibility, therefore, rests upon the

engineer in a diligent search for further economies to bring about the desired results, and I am sure the solution of a large part of this intricate problem lies with you gentlemen, members of the Maintenance of Way Association.

Sir Thomas R. Price.

When you were good enough to invite me to be present at this gathering I very gladly accepted your invitation as offering me the opportunity of being among railway comrades in the United States of America, if you will permit me to regard you as such, but that pleasure was considerably minimized when I heard that it was expected of me to address a gathering such as this in a country where there are so many capable and not a few eloquent speakers. I think I might have been inclined to deny myself the privilege of being present, notwithstanding my desire to make the acquaintance of railway men in this country of yours, but for the fact that I was glad to have this opportunity of testifying as only I am able to do, how greatly I appreciate and how greatly the government I represent will appreciate the friendly good will and the unmeasured cordiality and assistance the railway administrations of this country and their officers have extended to me.

It may seem invidious to single out any particular railway administration, or any particular officers, who have extended this cordiality, remembering that one and all have desired to do so, and I believe would have extended similar assistance in carrying out the mission entrusted to me had the opportunity offered, but the assistance that has been given to me by some of the railway administrations and officers has been so conspicuous that I feel I ought to mention them particularly. One of those I desire to mention is the gentleman who has just spoken. When the purpose of my being in this country was explained to him, nothing could have been more ready and cordial than the manner in which Mr. Felton not only offered valued facilities, but went out of his way to get the information that he himself possessed. Similarly I ought to mention Mr. Underwood, president of the Erie Railroad, and Mr. Cook, the general traffic manager. I wish also to convey my thanks in this public manner to the president and officials of the Burlington Railway who gave me similar facilities for seeing for myself the conditions under which you carry on the operations concerning which we in South Africa desired to have the benefit of your experience.

The other reason that I felt myself warranted in trespassing on your time was to take the opportunity of bearing testimony of those from whom I come of their high regard of the railway men of America, and the great things which you are accomplishing. I want to refer to some of the people in our country. I shall not mention any of those who are living, because I shall hope that they will continue to do the great things they have been doing in the past in South Africa, and if it should happen that they ever leave that country (I make you a present of this statement), they are very likely to come back again. But I will mention a few things as indicative of what your people do when they go to a country that really ought to be almost as dear to you as it is to us and that is some portions of the British Empire.

I will instance three men; they have gone to their rest and I am glad to have the opportunity of just mentioning the experience because I am able to speak from personal knowledge. Probably none of you approved of what was known in South Africa as the Jamieson raid. I am not here to defend it; am not here to explain it. I am a government official now, I was a government official then, and therefore in any case my mouth would be closed. But amongst the reformers who went to Pretoria jail, there was more than one who came from your own country and who are so far as I know, still citizens of America. One of them was an old man—his wife is still living, and one of the sweetest women I have had the privilege of knowing. That old engineer of yours and his wife, in the Pretoria prison were the comfort, the life, and, shall I say, the support, of the hundred men who were locked up in the building out of which they could have gotten any day in the week. Now that is the type of man that endears your countrymen and your country to the British Empire wherever the English language is spoken.

In the late war in Kimberly one of the men who stood out most conspicuously, and who rendered magnificent service during the siege, was again an engineer and a countryman of yours. Under the greatest possible difficulty he proceeded to manufacture guns and ammunition, he was a leader and guider and an able man in deed and in action in connection with the defense of Kimberly during the siege. And he did what those who are dear to him ever will be proud of, he gave his life to the country that he had made his home, and for the benefit of his associates with whom he was in daily contact. During the war, just when he was performing very, very able service, his life was cut short by a stray bullet that came from the besiegers. I honor him, and you may well honor the memory of such a man.

The third man I would like to make particular reference to is a man that perhaps some of you may have known, many of you have heard of, and that is your countryman, Louis Seymour. Louis Seymour again threw in his lot with those with whom he had been associated before the war began, and I am able to testify that he believed he was justified in doing so, and that the circumstances justified the action he took. Now, what did Louis Seymour do? When they had to leave Johannesburg, he came down and was the life and the active associate of all the others who were taking action, not only to do the best he could, and they could, for the cause they believed to be right, but he promptly occupied his time in devising means for improving the working of the gold fields as soon as the war was over. And I had the great pleasure of being associated with him in planning a type of trestle that you had been using in America, and adopting a type of truck that we know as the Hopper gold trucks—(you call them dumping cars, I think). While the war was on, the plans were prepared so as to have everything ready immediately the war was over, and we proceeded to place orders in America for the necessary trucks to arrive, so as to have them in time to commence the work. Not only that, but as soon as the war was over he offered his services, and then gave them magnificently in the position he was placed in, in charge of the repairs and renewals of the broken bridges along the railway lines. The work that he did in the repair of a bridge such as Norvalen Punt, adjoining Cape Colony, in the Free State, and following the British Army on and on, to repair the bridges that were broken, is a standing monument to Louis Seymour, and his memory is held very bright and very green in Johannesburg. The Seymour Library in connection with the Technical College at Johannesburg, is the best reference library in the southern hemisphere. No money was spared in establishing that library; no money is spared in maintaining it as the best library in South Africa. He gave up his life for the cause that he believed to be just, and at all events he gave up his life fighting with his comrades at a time when that fighting took the form of re-erecting a very important bridge and also defending the operation against attack. When you have such men as these—and I have only mentioned those who have gone to their homes—can you wonder that we, when we get the best type of your countrymen amongst us, marvel why it is that there should be any difference between you and ourselves—(applause)—and can you wonder that, when I come among you and am received with the welcome and cordiality that has been extended to me, I regard you in the same light that we regard so many of our countrymen who are in South Africa and whom we feel

delighted to have the opportunity of regarding both as comrades and as friends?

I am not going to weary you with the details of the railways in South Africa. You know about them in the same way that we know about your railways, but there may be one or two facts that would interest you that I should mention in passing. The first is that you gauge is known as the standard gauge practically the world over; ours is the gauge of 3 feet 6. Many of the appliances you have, we have. We have the opportunity of knowing what you are doing. We take advantage of that opportunity. In some cases we do not follow your practice because we believe that local conditions and the solving of the problems have required different methods.

The only line that I would like to mention, by way of illustration, is the line that used to be considered visionary, viz.: the line from the Cape to Cairo. That line has already reached Congo Free State from the south. Roughly speaking, the distance from Cape Town to the terminus of that railway is about the distance that it is from here to San Francisco. People think that it is a visionary project, but I believe you will live and others will be living who are now alive, and in middle age, who will regard it as altogether a mistake to think the Cape to Cairo Railway is visionary.

I would like to say one last word, and that is to refer to the impression that my second visit to your country is likely to form on my mind. It is too soon yet to finally determine, but so far as I can judge the impression will be not so much that of an education, because, as I say, we keep ourselves informed on what you are doing, but rather of an inspiration and incentive, and I know of no place better than Chicago to bring about that feeling. Here you are in the center of America. You have no minerals immediately within your borders, and yet you are in a town that, less than eighty years ago, I am told, was reported upon by your government as a spot that ought to be abandoned, the soil was no good, the whole place should be left to its fate. Less than eighty years has brought about, if you will permit me to say so, the establishment of your railway communication that gives you about the largest city in the world; that has enabled you to become prosperous on traffic and at rates that are considered to be usually unremunerative. That is due, as Mr. Felton rightly said, to your endeavors and the result of railway communication. I shall go away with the feeling that you have inspired us, you have set us an example that it will be our business to copy and emulate, and mixed with that feeling will be the pleasant memory of the cordiality you have extended me, the very warm welcome you have given me and the remembrance of the service I have received at the hands of my comrades in the United States. The honor that I have received here tonight from you who have so patiently listened to what I have imperfectly said, will be a particularly pleasant memory to me and to those who care for me in years to come. (Applause.)

Prof. Louis C. Monin.

As a substitute for my chief in this splendid gathering, following the distinguished speakers of this evening, I feel indeed like the little girl who was playing one day in front of her house. Mother was watching her and Mother thought Elsie was naughty. Mother said, "Elsie, come in; I want to speak to you." Elsie said, "Mother, before you speak to me, will you permit me to say my prayers?" Elsie went to the corner by her mother's permission; she knelt down and said, "Oh, Lord, if ever you want to do something for Elsie, now's your chance."

I appreciate very much the honor I have this evening in addressing a gathering like this, and on a topic so broad—a topic which has been discussed so often that it would seem there is hardly anything new to be said—the topic of Education.

The only qualification that I have, I think, which will permit me to stand up amongst you as engineers is the one, that at five o'clock, our president said to me, "You must go and address the gentlemen in my behalf." I obeyed orders. It is the best a man can do, and I think you will all sympathize with me in my endeavor to obey orders.

A few years ago a Spanish nobleman, the Duke of Medinah, inherited, by the death of his father, his estates and his vast realms. According to the custom in Spain, the young gentleman had to present himself before the Queen Regent at the time when the entire court was assembled. He had to enumerate the valiant deeds of his ancestors, and show why he should be entitled to succeed to the dukedom. To the great astonishment of Queen Christiana, and her court, the young man, instead of making a long address, enumerating what his ancestors and forefathers had done, with a very few words laid at the feet of his sovereign, the diploma which he had just received when he had finished his course at the Polytechnic Institute at Madrid and received the diploma of civil engineer. He said: "This is my claim to the dukedom of my fathers." (Applause.)

This young man may have valued his diploma somewhat too much and yet I think he did it in the right spirit, and he did it in the spirit which we should like to inculcate at the Armour Institute of Technology in the young hearts and in the minds of those who are going to follow you in your work; for it is not merely for material matter that the engineer is working, but for human welfare in general.

With this point in view, I am sure you will pardon me if I dwell for a few moments upon the ideals sought in the education of an engineer. What are the things that we must teach? First, we must give the student all that he needs for his own development; second, we must fit him for that which the community needs, and is going to ask one day from him.

In the foreground of our endeavors of work, of course, is the daily task, which comes to every man who has to perform his work. He is to be an engineer; he has to make a living, he has to be an intelligent producer—these ends have to be kept in the foreground in working out the ciriculum of an engineering school.

In the back ground, however, is the idea of the personality. Performance and personality complete the man. This personality is made up of general culture, of character, of a great purpose. Behind the work is the man, behind the engineer is the citizen, behind the living is the life, behind the intelligent producer is the intelligent consumer. It would seem often as if our educational agencies were thinking perhaps a little too much of training the intelligent producer, and not giving enough time and thought to the training of the intelligent consumer. Dickens says: "Income, 20 shillings, expense 18 shillings, balance—happiness. Income, 20 shillings, expense, 21 shillings, balance—misery." It is a good engineering lesson to teach to our boys.

In regard to the performance of the work, what is needed in the performance of every man's work, and especially in the performance of the work of the engineer? I wish to bring before you vividly and sharply the ideals as we conceive them, that ought to be implanted in the hearts of our young engineers. Performance means to be master of one thing; be in sympathy with a great many things, but be master of one thing. The man must have enough power in himself to make an effort. The engineer knows that he can gage mechanical and other work by units. We have the horse power, the ampere, the volt, but fortunately we have not come to gage human effort by such units. It would be a splendid thing if every man could be given a ticket and holes punched in the ticket according to the work performed by him—for so many units of work, so many units of meals, of sleep, and house and dress, and what-not, but we cannot do it.

Our educational work has gone on within the last twenty years in a way that is not quite fitted to develop fiber in young men. We have been told we must make it interesting. A father came to me once and said, "I don't want

this boy to be bothered with mathematics. It is not in the family." I answered, "Why, my dear sir, it ought to be." (Applause.) You don't make an athlete by putting him in an easy chair, never letting him go out into the field and practice until his muscles have grown strong. If you keep him in an easy chair, and all at once you send him to battle and expect him to win victories, you are disappointed. You must teach him to do the uninteresting things well; to make the commonplace significant, and first of all, he must know his business.

Chesterton says the only way to become a successful whist player is to learn the rules of the game in the first place, and then play it a little better than everybody else, or cheat. (Laughter.) Of course, gentlemen, I suppose that none of us, especially anyone occupying the position of an educator, would give the last advice to the student. Learn the rules of the game. That is well to tell our boys. Study your subject. The least we can require from you when you graduate from our school, is that you know your business. You do not need to be petted or sent on a trip abroad as a reward for what you have done in your studies. You will have to learn these things later on. It is only by expert service that we climb up the ladder of success. We tell our men to learn the rules of the game, and when they go out into the world to play a little better than everybody else, and they will be successful.

In regard to the characteristics and character of an engineer I have hunted for many years for information, and so far I have succeeded in getting together thirty-six prominent characteristics necessary for a prominent engineer. (Laughter.) I will not weary you, as we weary our Juniors and Seniors, by giving an hour's lecture on each, but at the bottom of it all it seems to me that the character most needed by an engineer is one that sees the difference in life between that which is fundamental, that which is merely supplemental and that which is incidental. The great trouble with our boys is that they devote their lives between the fundamental and the incidental, so much studying and so much fooling, and there is nothing between.

We think in our institution that the man who can divide his life's work, his reading, his energies, the attention he gives to his profession, to state, church, school, social institutions in the right proportion of, say about 60 per cent. to the fundamentals; making your living, about 15 to 20 per cent to the supplementals that go to make life livable; art, social intercourse, etc.; and perhaps only 10 per cent. to the incidentals—the moonshining and the lovemaking. Behind all these ought to be the greater purpose, the man with an outlook, the man who can make the greater effort, the man who is not bothered when things go wrong with him, for whom the whole horizon is not clouded when the machinery is broken.

Above all, gentlemen, we must try to inculcate a spirit of courage, a spirit of patience. Let us say with the old statesman of France, Thiers, whose watchword was, "I shall begin again!" When he was thrown down, whenever he lost a position, whenever his opponents threw him out of the cabinet, all he would say was, "I shall begin again." I think this is the true engineering spirit, and if you add to this what every citizen, what every true man must add—the three S's, that I should call preeminently the symbol of the engineer's work and the engineer's life and character—sincerity, simplicity and service—you have an engineering education that beats the world. According to the German poet, "He only deserves liberty as well as life who is to earn and win them by his daily toil." These are our ideals. (Applause.)

Hon. John Barton Payne.

I have been thinking, as these gentlemen have been talking and we have been listening, about maintenance of way. Omit "maintenance of" and you have "way." Do you recollect what "way" means; how, from the dawn of civilization, the ways of the world, its roads, its highways, have marched forward as the leader of civilzation? How, in Rome, her civilization was evidence by the fact that she built roads and bridges throughout the remotest sections of her empire? To-day, in Spain and the lower countries and other places far from Rome, you see the roads and the bridges built by the Roman emperors. Water was brought to Rome by these great creations which now the engineer represents. In the early history of our own country it was regarded as a feat of so much moment to build a national highway out through the west, and not very far west, that Henry Clay has a monument standing to his name to-day near Wheeling, W. Va., because he originated the national road. Compare the railways of the United States and the railways of other civilized countries with that phase of civilization. The men who guide, create and direct the railways of this country should be the leaders of thought as well as the leaders of action.

Ways dominate civilization always. I do not think we should be disturbed about the phase of legal difficulties through which we are now passing. It is merely a phase and we will outgrow it, grow out of it, triumph over it as clearly and distinctly as we have over difficulties which confronted railway building when we were compelled to build railways throughout the west by country subscriptions.

You know the history of the past in dealing with railway construction. We were simply marching toward the west. We were simply leading the van of civilization through the west, and now that civilization has settled down in some sort, difficulties which confronted railway construction and operation are now exemplified by the 46 or 47 or more state commissions and the great commission of the United States. We must be wise enough to adjust ourselves to these conditions. We must be bright enough to lead in these conditions; we must be strong enough to impress upon the people of the country our conviction of the right in dealing with these conditions. We are growing through state commissions, through every state through which a railway goes; there is the commission to deal with, and that commission restricts, interferes with and, in some sort of way, controls by its often unwise and restricted and selfish action, the dominating power of the United States. What must be the result of this? After a while the United States Commission, by the addition of power given by congress, so far as congress has the right, and by the construction of the constitution which the supreme court of the United States must ultimate make, will assert and exercise the power of dominating rate making and railway legislation to such an extent as to dwarf the power of the state commissions, and when we reach that condition—(applause)—we shall so have impressed ourselves upon the power of congress and upon its wisdom, that congress will give to the railways of this country that power and encouragement which will enable the railways to take the place which the ways of the world have always taken and held. (Applause.) And the only word from the legal department of our road is that we shall be wise and patient and that we shall not beat ourselves against the pricks, but deal with these conditions wisely, because it is a phase of civilization through which we must pass. (Applause.)

W. B. Poland.

I am going to assume that you don't know anything more about the Philippines than I did when I went out there, which was almost nothing, and give you a few facts in regard to them.

First, the Philippines lies about 20 deg. north of the equator. You will see that they are somewhat nearer to the equator than Cuba and Porto Rico. The climate is divided into two seasons, the wet and the dry seasons. They are about six months each. During the dry season, which is from September to the end of May, the climate is almost ideal. During the rest of the year it is very hot, until the rains begin, and then it is quite comfortable, although it is disagreeable until a man becomes accustomed to the rainy season and accustomed to being wet two or

three times a day. As to the general healthfulness, if a man does not drink too much whiskey and carries out a few precautions such as drinking boiled water and eating only vegetables which grow out of the ground, he will have the very best of health, probably better health than he would have in the United States. In fact, the percentage of deaths per thousand is much less among the Europeans in the Philippine Islands than it is in the United States. That of course is largely due to the fact that they are more or less picked men out there, and there are not so many women and children.

Now, the area of the Islands is about 115,000 square miles. About half of that is arable productive land, and the other half is mountainous country. A good deal of it, however, is good grazing land, and is capable of producing a good deal of revenue. The population is about 8,000,000 and, of that eight million, seven million is so-called civilized. The remaining one million consists of the hill tribes, which are, although not altogether, principally savage. They are, however, being civilized very fast and made into a productive people.

It is rather interesting to consider the races which are in the Islands. Apparently they were first settled by what I call Negritos, who have a good many traits of the Africans; but they are very small people, not over five feet in height, and they are very timid. These Negritos were driven to the tops of the hills by what are now called the Montascos, meaning the people living in the mountains. These people undoubtedly originally lived in the lowlands, but as the Malay invasion, which populated the Japanese Islands and Kamstchatka, and afterwards undoubtedly the Aleutian Islands, and our Alaskan Coast, flowed over into the Philippines, being a good fighting people they drove these Montascos up into the mountains. So we have three sets of people there—first, the Negritos, who are the very primitive people, in fact, live in trees to a large extent, and probably not more than 500,000 altogether; then the Montascos, who probably number about 750,000; and then the present Filipino population, which is composed of the Malay invasion, associated with the Japanese and Chinese, principally Chinese and an admixture of other races, which have come in within the last hundred years, as, for instance, the English, and largely the Spanish, and French and other European races. Now, the Filipinos who live in the lowlands are what are usualy referred to as the Filipino people. They are not a homogeneous people. They associate very little, one part with another, so that the people who live on one Island know very little of the language and customs of the people who live on even a closely adjacent island; they do not even speak their language. So that it has been very hard to get any national spirit there. For that purpose, the Filipino Government has instituted the teaching of English, all over the islands, and at the present time there are more English-speaking Filipino than there are those who speak any other language.

You may be interested in the form of government there. There is first, a governor general, who was appointed by the president of the United States; he is supported by a council of seven commissioners, four of whom are Americans and three are Phillipinos. That forms the Philippine commission. Then there is the Philippine assembly, which is an elective body, and consists, as I remember, of about eighty or one hundred members. Any laws in the Philippine Islands must be passed by both the Philippine commission and the assembly, and approved by the governor general. The islands are then divided into provinces, over which there is a provincial governor, who is elected by the people; and under him the province is divided into municipalities, over which there is a municipal presidente, and a council. Those are all Filipinos.

There is a supreme court which is composed at the present time of a majority of Americans—a majority of one, I think. The Filipinos on the supreme court are very able men, and there is no question as to racial decisions. A number of times, when questions have come up between Americans and Phillipinos, they have shown an absolute impartiality; so that there is quite a complete confidence in the decisions of the supreme court in the Philippine Islands, although there is only a majority of one American on it. In order to develop the resources of the Philippines the Washington administration decided that railways were very necessary. Concessions were given for the construction of 800 miles on the great island of Luzon, of which about 375 miles have been constructed. In the Vicene islands, concessions were given for the construction of 250 miles of railway, of which about 133 are in operation. In the building of these railways there were a great many difficulties encountered; the labor was very poor, indeed; there was lots of it but we couldn't get it. I at one time went to the presidente and told him that I must have 500 men on the work; he told me he would have them the next day. The next day came, and the men didn't, and when I went to the presidente, he said, "Well, senor, I went to the men in my district and told them that they must report to you for work, but they told me that they had two sacks of rice in their cabins, they had cocoanuts growing in their yards, they had fish in the streams, potato patches in front of their cabins, and they didn't see why they should work, and I really did not."

The real problem of the Americans in the Philippines is to make the natives unhappy, and make them want what they have not now—make them want shoes and clothes and better costumes for their women, and then we will make them work. Until we can make them unhappy, we cannot expect to get very much out of them. (Applause.) That is what we are trying to do now.

In regard to the construction of the lines in the Philippines we found at the outset it was necessary to adopt a very high standard. The depreciation in the tropics, as you know, is very rapid. We had to abandon wooden construction almost entirely. Everything is of reenforced concrete or steel. The surveys were very expensive. The men who went out on the surveying parties found themselves up against very hard conditions to overcome in transportation. They could not get food in the interior, and they had to hack their way through a dense tropical undergrowth which was almost overpowering in the heat and steam of the tropical sun. We had to build ladders for them to see over the brush, which grows from five to seven feet high on the plains. One of the great costs of the work there is the expensive drainage. The drainage areas are very small and the rainfall is frequently from fifteen to seventeen inches a day in the rainy season, which makes a small drainage area require a very large bridge opening. The equipment is all steel framed throughout. We use 60,000 to 80,000-pound capacity cars as a rule on a three-foot six-inch gage track. That is the so-called oriental gage, the same as adopted in the South African railways. The roadbed is about 16 feet, with 12 inches of gravel or stone ballast. The rail is 60 to 70 pounds, and the ties are of the native Philippine hardwood. They are supposed to last from 20 to 30 years, and they cost us $1 in the track. The buildings are all of reenforced concrete. The Philippine government guaranteed the interest on the bonds at the rate of 4 per cent. for the actual cost of construction in the Philippine islands that was necessary in order to interest foreign capital in the construction in a remote country.

In regard to maintenance, we find that the Philippinos are very satisfactory track laborers after they have learned how to use a jack and the ordinary track tools. We had a good deal of trouble at first, because they put the wheelbarrows on their heads when they were working instead of running it on the wheels. Now, we have gotten to a force of one foreman and two men for a five-mile section of single track and they keep the track up in very good shape under eight or ten trains a day. The operation is largely by Philippine labor. Our track men are Filipinos or Chinese and are becoming more and more Filipinos

Annual Dinner of American Railway Engineering and Maintenance of Way Association.

all the time. Of the train men, about three-quarters are Philiipinos, and they make very excellent engine men after a year or two of training. The engine men get about $30 a month and the conductors about $25 a month, so the operation is very economical. The section men get $15 in gold a month. The principal problem there that all the railways have is, to build up the country along their lines. There is probably no more productive land than that of the Philippine islands, but it is very little worked. I do not suppose they produce 25 per cent. of what they could produce, and the work of the Philippine government as well as that of the Philippine Railway Company has been to develop the sugar, rice, corn, copra and hemp products of the section, and we are meeting with very good success. We have doubled the output of the section adjacent to our lines, and it looks as if within the next four or five years it would be trebled or quadrupled. If that is done, it will make the investment in railways in that country a very satisfactory one from the standpoint of the investors in the United States.

The real turning point with the Philippine Islands came when the Payne bill was passed. Previous to that we had destroyed the Spanish market for the Philippines and had not substituted anything for it. The reducing of the tariff on Philippine products opened up a new market. The total production of the Philippine Islands, as to exports and imports in 1909, before the Payne bill went into effect, was $58,000,000. In 1910, it was $76,000,000, which shows very well what we have accomplished by that very concise legislation. Most of this represents a gain in trade with the United States.

The work which the Philippine government has before it might be summarized in this way: as to education, there are some 450,000 Philippino children, who are now in the schools, and it is easy to be seen that in the course of a year or two, or possibly five or six years, that will produce a good deal of effect on the Philippino people. Road construction is being taken up very vigorously by the provincial governments through the direction of the governor general. There are fine highways—turnpikes you would call them—being built between the different cities of the islands. There is a great development of harbor and river improvements, light house construction, etc., all of which tends toward the development of Philippine commerce.

One of the principal things which the administration is to be given credit for, is that of sanitation. There has been a very satisfactory sanitory organization put in all over the islands. The epidemics of smallpox, which used to carry off every two or three years some 200,000 or 300,000 people have been eradicated, and smallpox has been almost blotted out. Cholera, although you may say it is indegenous to the Philippines, as an epidemic, is almost unknown. This change has been brought about through the work of the Bureau of Public Works.

The whole effort of the government in the Philippines is to train the people for local self government. Just as fast as they show that they are able to properly handle their own administration of affairs without the help of American officers, districts are turned over to them so that the number of American administrators is steadily being reduced, and the number of governors, and mayors and presidents is constantly being increased; also the number of Philippine office holder in the civil government is constantly being increased as they show their capacity for government. This is an important thing for us to realize, because it does not seem to be appreciated by the opponents of the administration in their attacks in congress.

The development of the islands through agriculture, is being carried on through the agricultural department, which has a very efficient administration. They are introducing better grades of corn and rice, and teaching the people how to raise more from a given area of land than before, and the increase is very marked, in certain sections as much as 50 per cent. I think it will show an increase in the exports of the islands of nearly 100 per cent within the next five years.

The political situation in the Philippines is not, and probably never will be satisfactory. We expect the Filipino to recognize what the American government is doing for him and to be grateful for it, but he does not do that, and he never will in my opinion. It is the old, old case of the antagonism of an inferior people toward a superior people. We see the same thing in Egypt toward the English government, and in Java toward the Dutch government, and in India toward the English government. We never can expect anything else, but we have put our hand to the plow, and we must see the work through.

It was very interesting to me in making the trip from the Philippines to the United States to be able to compare what they were doing in the Philippines with what some of the other governments who are carrying on Colonial forms of administration were accomplishing. In Java, for instance ,they will tell you that they have a very much more satisfactory form of government. In a way it is so, but the people of Java are almost slaves. The Dutch governors there have as nominal rulers executives who are called sultans, and they will say to one of the native governors, "you must have your people cultivate this tract of land next year." That tract of land will be cultivated, and well cultivated, and the people will win from it a very good revenue, and they will be as you would think, content and happy. Undoubtedly their physical condition is much superior to that, for instance, of the Filipinos, but the reason that they do cultivate the land is because they know, from past experience, if they do not do it, they will be coerced, they will be forced physically to work even by means of the lash. That is not necessary now, because they have learned their lesson, and have become very docile. The result is that Java is a wonderfully cultivated island. Taking into account its natural resources, its production is probably three or four times that of the Philippines islands, but the people are nevertheless virtually slaves.

Going from Java into the Federated Malay states, which are under English control, we find there one of the most ideal colonial governments that there is probably in the orient. The whole country is governed by a handful of Englishmen who play the game to a finish. The country is being developed fast. It is being developed, however, by bringing into the country Chinese coolies, or the tamal or coolie labor from India. The result is that as far as the administrators are concerned, the country is advancing fast, but probably fifteen or twenty years from now you would find it difficult to discover any of the real inhabitants of the Federated Malay states. They are being driven out by this foreign invasion. The same thing to a less extent is going on in England's colonial estate in Burma. In India, the social condition is very complex indeed. In the past there is no doubt that England has entirely disregarded the interests of the people, but of late years that has been forced more and more upon them, and they are coming now to a realization that India must be governed in the interests of the India people, that is, they are coming to the American ideal of colonial government, which is that the country must be governed as a trust for the people of the country. In Egypt, England seems to have had that ideal before her more than in any other of her colonial possessions, but looking over the whole field, in making the trip from the Philippines to the United States, in passing through these colonial possessions, an American cannot but feel that we have performed a very creditable work and that we have marked out a new path in colonial government, and that as far as we have gone, we are making good. (Applause.)

ELONGATION AND DUCTILITY TESTS OF RAILS FOR NEW YORK CENTRAL LINES.

By P. H. Dudley.

The acceptance of rails under a single drop test of 2,000 lbs., falling a given height, rejects only those of less ductility than is required to take up the energy of the drop before rupture. This range of rejections varies from a small percentage of 1 per cent to 3 per cent of the output, and all in manufacture should be avoided.

Experience has shown that there are likely to be a number of heats of Bessemer and occasionally a melt of open hearth rails in which the ductility is just sufficient to absorb the energy of a single blow of the drop and pass the rails. The butts, however, will break from a second blow without giving any increased elongation, while a number of the rails are so severely strained by gagging in the straightening presses that the strains develop into checks and detailed fractures from service in the tracks.

The percentage in plain Bessemer ranges from 2 to as high as 15 per cent in some rollings, and is yearly increasing in this class of rails. Eighty to 90 per cent of the heats of Bessemer or of the melts of open hearth require two or more blows under the drop to break them, giving a desired range of 12 to 18 per cent of ductility in the rails for service as girders, which experience shows has rendered excellent service in New York Central Lines, where the temperatures often fall to 30 and 40 deg. Fahr. below zero. It is only natural that railway officers should try to secure as good or better material as was possible from 1890 to 1900, in rails for their constantly increasing wheel loads and speeds.

The 1890 specifications of the Boston and Albany and New York Central & Hudson River for the low 0.06 phosphorus and 0.60 to 0.65 carbon Bessemer rails, required a drop test from each heat and that 90 per cent should stand a test of 2,000 lbs. falling 20 ft. without breaking for either the 80, 95 and 100 lb. sections. To this requirement, then, was soon added, "That a butt which broke, yet gave 4 per cent maximum elongation per inch, the rails of the heat would be accepted." It is but proper to say that while a few of the rails had a minimum range of 4 per cent ductility, the majority had from 8 to 16 per cent, and comparatively few breakages occurred. The surface wear and flange abrasion were of slow rates, the rails lasting two and three times as long as more recent Bessemer rails.

To carry the present high speed wheel loads, the former minimum elongation of 4 per cent per inch has been raised to 6 per cent for the maximum inch or two consecutive inches must each give 5 per cent. The ductility of the metal must be exhausted in the test butt from Bessemer heats in which the equivalent of one-tenth of 1 per cent of metallic titanium has been used in the bath of steel. The range of ductility secured in this steel is the minimum specified to 18 per cent per in., though the range of the majority of the heats is from 11 to 16 per cent. The Bessemer heats each, according to weight of section, makes from 18 to 30 rails accepted or rejected by one ductility test.

The basic open hearth melts of 60 to 80 tons each making from 100 to 150 rails, according to section, are accepted or rejected upon the results of three ductility tests, one from the second ingot, one from the middle ingot of the melt, and a third from the next to the last ingot teemed. To accept the rails of the melt each test must show 6 per cent maximum elongation for 1 in., or 5 per cent each for two consecutive in. The ductility of the metal is exhausted in rotation from each of the different tests of the melt and we thus ascertain the general uniformity of the steel of the first to the last teemed. This has tested, but not confirmed, a published statement that the first steel teemed is liable to have so high a temperature that it will be brittle; while the middle ingot will have a proper temperature and be tough, the last ingot will be teemed of steel so cold that it will be brittle. This does not seem to apply to these large melts of rail steel, as shown by the ductility tests. Basic open hearth rails have been rolled under these specifications at Bethlehem, Buffalo and Gary.

The three tests per melt on the open hearth rails call attention definitely to several conditions of mill practice which in hot metal must proceed at the right temperature in a logical and orderly manner. A melt or two at first did not pass, but the causes for failure could be quickly ascertained and remedied in the following melts, the making and rolling of the steel proceeding in a more satisfactory manner to both the manufacturer and customer. The specifications provide that a distinction must be made between a chilled butt and one that is brittle, before acceptance or rejections of rails are made, while the full ductility tests give the low as well as the high range, facts not before available for the manufacturers to study, and guide their efforts to secure the desired range.

The specifications are intended as an aid to good commercial work in manufacture for the necessary quality for present service as well as output. Attention is called to good mill practice after the ingots are teemed and set on top; they should be promptly stripped, weighed and charged into reheating furnaces. This is to avoid unnecessary cooling of the metal developing large shrinkage cavities in the ingots from the inexorable law that molten or hot steel has a greater volume than when cold.

The management of one rail mill has organized a railway service for uniform prompt delivering and charging into the reheating furnaces of its large ingots, with the result of nearly entire elimination of piped rails, under the commercial discard.

CHICAGO PASSENGER SUBWAYS.

Bion J. Arnold, chief subway engineer of the city of Chicago, has prepared general plans for a complete subway system for the city, in a report transmitted to the mayor and the committee on local transportation of the city council under date of January 31, 1911. Detailed construction plans for the complete work are not yet finished, pending the decision of the city council on the financial policy to be adopted. The information compiled by Mr. Arnold in preparing his report is very complete, covering foundations, underground utilities, occupancy of sub-sidewalk space, the character of soils and other difficulties that would be met in this construction.

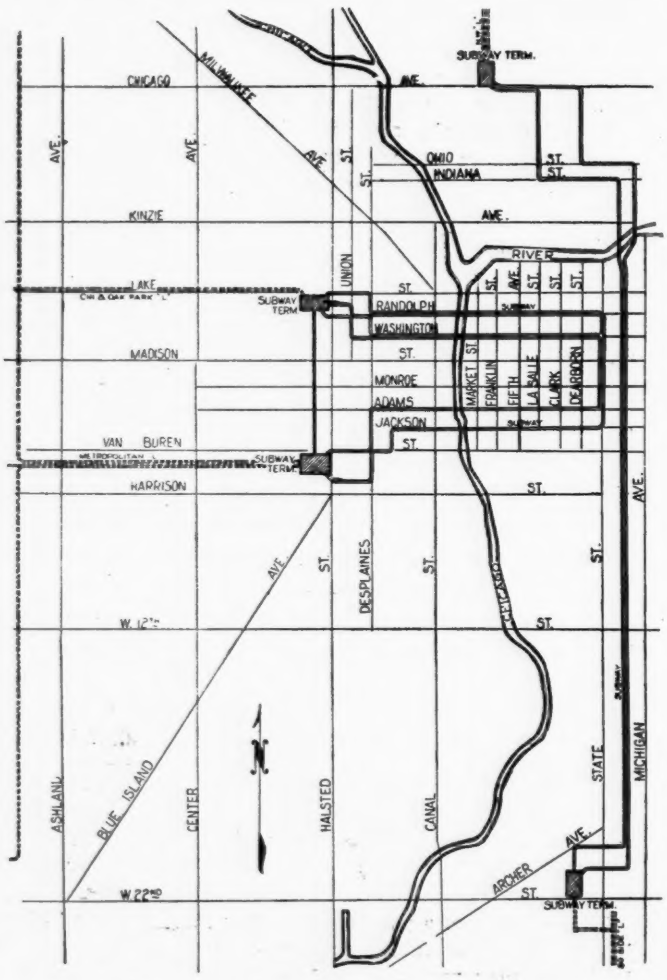
The building of a passenger subway for the city of Chicago has long been considered and many plans have been proposed. In 1900 a plan prepared by John M. Roach, president of the Union Traction Company, was presented to the council's committee on local transportation by all the street railway companies operating in the city at that time, the intention being to build a system of terminal loops to accommodate surface cars without providing for any through routes. These plans were not acceptable to the city council, and in pointing out some of the defects in them, John Ericson, city engineer, drew up a tentative plan, embodying the features that were thought essential, but no definite action was taken on his proposal.

The building of the conduit or tunnel which was begun by the Illinois Telephone & Telegraph Company, and which, after changing ownership several times, is now operated as a freight tunnel by the Illinois Tunnel Company, complicated the design of plans for a passenger subway, since its depth below street level made it extremely difficult to provide for a two-level passenger subway above it.

In 1904 the government ordered the dredging of the chan-

nel of the Chicago River, to allow navigation of the river by large lake steamers. This necessitated the lowering of the three river tunnels that had been built to remove street car traffic from the bridges. In planning for the rebuilding of these tunnels the question of a subway was again revived and the council committee on transportation had one of the assistant city engineers prepare plans for two subway loops connecting the Washington street and La Salle street tunnels and the Washington street and Van Buren street tunnels. It was the intention to run all surface cars using the tunnels through these subways in the loop district.

George W. Jackson, who was the builder of the freight tunnels, proposed a plan for passenger subways as early as 1902, and in 1904, in accordance with a commission by the city council, he presented a report covering the complete local transportation situation, in which he advocated



Subway Proposed by John Ericson, City Engineer.

building of passenger subways, with two routes to the south side, two to the west side, and one to the north side.

In 1908 the mayor sent a communication to the city council, asking for an investigation of the passenger subway problem, in order that the municipal government could seriously consider the question of providing such transportation. In accordance with this request, Mr. Ericson, the city engineer, prepared a very complete report on the subject, which was transmitted to the city council under date of January 2, 1909. Plans submitted with this report provided for the traffic on the elevated roads, as well as those of the surface lines, which further complicated the problem, since no previous plan had been drawn which had in mind the provision of facilities for handling the trains of the elevated roads in the subway. A great amount of local transportation data was collected upon which to base conclusions in the design of the subway. These statistics showed that the population of the Chicago center was 2,172,000 in 1906, and according to the best estimates would be 6,000,000 in 1950. Since it is known that the ratio of increase in the number of passengers in a local transportation system is greater than the city's population, it was estimated from the statistics of past traffic that the number of rides annually per capita in 1940 would have reached 404. The figures for past years were as follows: In 1885, 100 rides per capita, population 850,000; 1908, 230 rides per capita, population 2,300,000.

The routes for subways proposed by Mr. Ericson are shown in the accompanying map and were intended simply as the first steps in the building of a complete system of rapid transit for the city. The plan as outlined includes three main subways, a north and south line extending through the business district on Wabash avenue, and two east and west subways forming loops on Jackson boulevard and Randolph street and Adams street and Washington street. The terminals of these subways are arranged so that elevated trains can be diverted to them, as well as surface lines, from a large district radiating from the termini. Since the north and south lines of the loop subways are on State street, there are no crossings involved in this system, and the entire length could be built at the high level.

Various other systems for providing for rapid transit have been proposed by engineers interested in the city's development. One of the most recent of these is the shuttle system, outlined in a paper presented before the Western Society of Engineers on February 8, 1911, by A. S. Robinson. This plan proposed building a through north and south subway on La Salle or Clark streets and a loop from the west side on Washington, Clark and Van Buren streets, with the addition later of four or five parallel north and south lines, and as many more additional loops from the west side radiating to the northwest and southwest, so as to eventually serve the entire residence district of the city. This plan was not strictly a two-level design, although within the loop district, where crossings were numerous, Mr. Robinson planned to avoid grade crossings by depressing one of the lines under the other. No stations were planned for the low level, however, to avoid requiring passengers from any section of the city to use the lower stations.

Bion J. Arnold was appointed chief subway engineer of the city in 1910, and proceeded at once to submit a report. In preparing his plans, Mr. Arnold seems to have eliminated most of the undesirable or impracticable features of the numerous plans that have been advanced, and it now seems probable that some definite action upon his report will be taken at an early date. This report includes two alternative plans, one for a comprehensive subway system to care for surface, elevated and high-speed subway cars, and the other for a system providing exclusively for surface cars, with the object of relieving the present congestion in the business district.

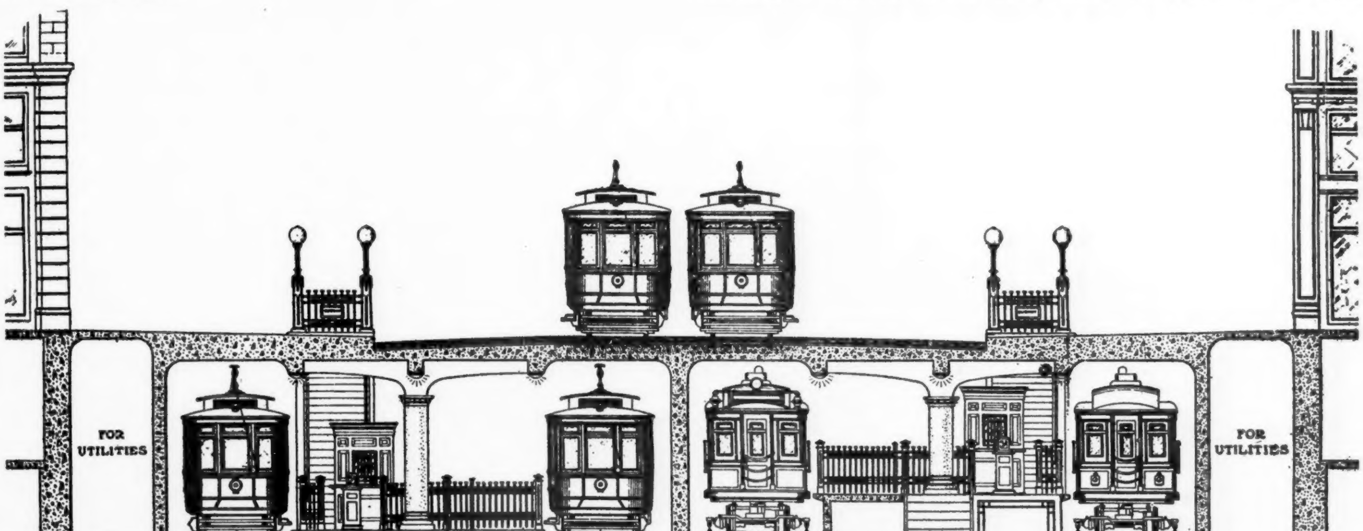
Mr. Arnold says in his letter of transmittal that no subway plans should be adopted involving any system of loops which would prevent the building of a high-speed subway system which will ultimately cover the entire city, for no extensive subway building can be justified as an investment unless the operation of such high-speed trains resulting in low operating costs is provided for. The report does not attempt to deal with the financial aspects of the situation, as it is held that regardless of the possibility of justifying the investment from a financial standpoint, the building of the subways is desired by the city to relieve the present congested condition. The complete system should provide for through operation from southern to northern termini, for similar operation on east and west lines, with loop terminals in the business district, and eventually diagonal subways on diagonal streets to connect these north and south and east and west

lines. The complete system has been divided in the report into a number of parts, with the idea that the parts can be built consecutively as the available capital and other conditions warrant. The portions included in each step are arranged to afford their proportionate share of relief for present conditions, the relief being commensurate with the investment necessary for building each part. The first step would provided a through north and south subway and a double loop from the west side, to relieve much of the surface line congestion in the loop district. The second step would furnish a north and south line to care for the trains of the Northwestern Elevated and the South Side Elevated, and two loops from the west side, one for the Chicago & Oak Park, and one for the Metropolitan Elevated trains. The building of this second section would make possible the removal of the present elevated loop. Step No. 3 would connect the two west side loops for elevated trains, allowing through routing and a more universal service. The fourth step would provide a loop on Chicago avenue, Michigan avenue and Twelfth street, which, in addition to the sections previously built, would furnish a connection between all steam railway passenger terminals in the city. The accompanying map shows the combination of these four steps, with all the stations recommended by Mr. Arnold. Further steps are provided in the report, to care for future needs as the city expands, but these cannot be accurately forecasted and must be largely conjectural at present.

The bore of the subway, according to the plans submitted, would be of reinforced concrete steel construction, with combination eye-beam and concrete construction in some instances. The size of the bore would be such as to allow the cars now used on the elevated railways to pass through with ample clearance, although the provision for this size involves some additional expense over a subway intended only for surface cars.

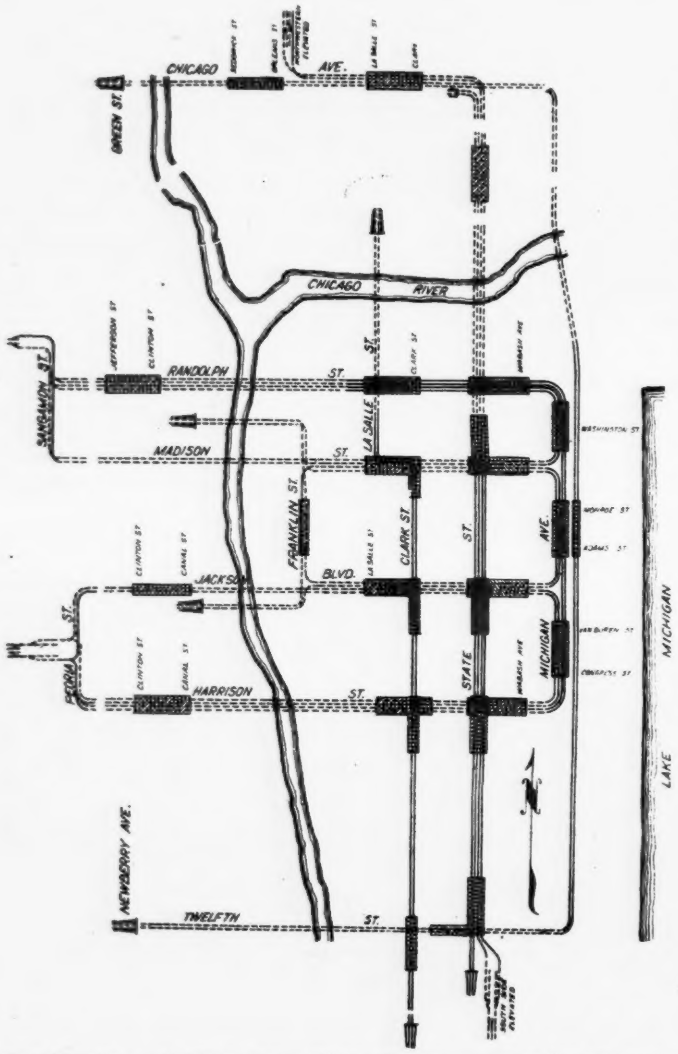
The plans proper do not seriously interfere with the structure of the Illinois Tunnel Company, although at some points this tunnel will have to be slightly changed. The design permits a shallow construction on the high level subways, allows sufficient room for the low level subway to pass under the high level and over the Illinois tunnel, and also allows the low level passenger subway to be placed almost as close to the surface of the streets as the single-decked subways of other cities where mezzanine floors are used. On account of the fact that the freight tunnel is so near the surface that the general use of stations with mezzanine floors is impossible, it will be necessary to increase the width of sidewalks on some of the streets to provide direct stairways from sidewalk to the platform of the high-level subway. The accompanying cut shows one of the recommended stations, the tracks being so located that the entrances to the station can be made directly from the sidewalks without the use of a mezzanine floor. In the stations as designed the cars of the high-level subway will be easy of access from the streets, and passengers will be able to reach the low-level subway without excessive exertion by using the escalators.

The general arrangement of the stations provides straight train or car platforms of sufficient width for all traffic, to or from which passengers may pass expeditiously. Congestion will be avoided by providing that traffic in one direction will not be crossed by traffic in another direction, and at stairways to be used jointly by passengers entering and leaving, railings will be provided where practicable, to separate the traffic going in opposite directions. In general, the island platform type of stations will be used, which is one with its train or car platform between two tracks, so that passengers may be discharged from or loaded upon trains on either side of the platform. If the traffic is to be handled by trains, the platforms will be long enough for trains of ten cars, or 500 feet in the clear, which will permit passengers



Cross Section of Subway Station Looking North in State Street at Jackson Boulevard.

to enter or leave through the vestibules at the end of each car in the train, or through side or middle car entrances. The width of the island station platform is limited by the amount of space available for tracks and stations between the building lines of streets in which the subways will be located, thus limiting the width to 16 feet in most cases, yet giving sufficient capacity for the passenger traffic of trains on the two station tracks at the same time. The stations for passengers using cars of the surface lines not running in trains will have platforms not less than 250 feet long, to permit the operation of cars in strings of at least four cars, not coupled together, but with sufficient space between for safe operation. In addition to the length of train or car platforms required for passengers to enter and leave trains or cars, additional space will be required at each end to



Combination of First Four Steps Recommended by Bion J. Arnold.

provide room for stairways from the street surface, ticket booths, news-stands, telephone booths and public comfort rooms.

The types of high-level subways suggested have sufficient space on each side of the subway structure for utilities. The low-level subways in general permit the location of utilities overhead in galleries, either outside or inside the curb line, and except when the open-cut method is under way at stations, existing utilities need not be distributed.

Mr. Arnold's report includes a detailed estimate of costs of the various steps recommended, which are briefly extracted below: Step 1 will include a two-track subway having 4.128 miles of single track and four stations, at $726,710 per mile, a total of $3,000,000, and 3.663 miles of single track subway and six stations, at $1,364,950 per mile, a total of $5,000,000. Step 2 includes a four-track subway with 10.184 miles of single track and five stations, at $768,550 per mile, a total of $7,750,000, and a two-track subway with 9.5 miles of single track and 14 stations, at $1,421,100 per mile, a total of $13,500,000. Step 3 provides for a two-track subway with 5.954 miles of single track and nine stations, at $1,049,710 per mile, a total of $6,250,000; and step 4 is a two-track subway with 8.78 miles of single track and four stations, at $1,104,780 a mile, a total of $9,700,000. This makes a total estimated cost of $45,200,000 for the first four steps suggested.

NEW CHICAGO PASSENGER TERMINAL OF THE CHICAGO & NORTH WESTERN.

The new passenger terminal of the Chicago & North Western at Chicago, the general design and construction of which have been described in the Railway Age Gazette from time to time, is now nearing completion. The building of this terminal includes not only the constructoin of the terminal building and train shed but elevated approaches connecting with the main lines west about two miles out from the station and north about a mile and a quarter.

The terminal station building has an east and west frontage of 320 ft. on the north side of Madison street, and a north and south frontage of 218 ft. cn Canal and Clinton streets. It is a four-story structure of the early Italian Renaissance style of architecture, with a lofty Doric portico at the Madison street entrance, supported on a colonnade of six granite columns. Immediately back of this colonnade and entered by three great arches is a vaulted vestibule, 132 ft. wide, 22 ft. deep and 40 ft. high. At the end of this vestibule are broad granite staircases leading to the main waitingroom. The interior arrangement of the building was fully described in the Railway Age Gazette of August 14, 1908.

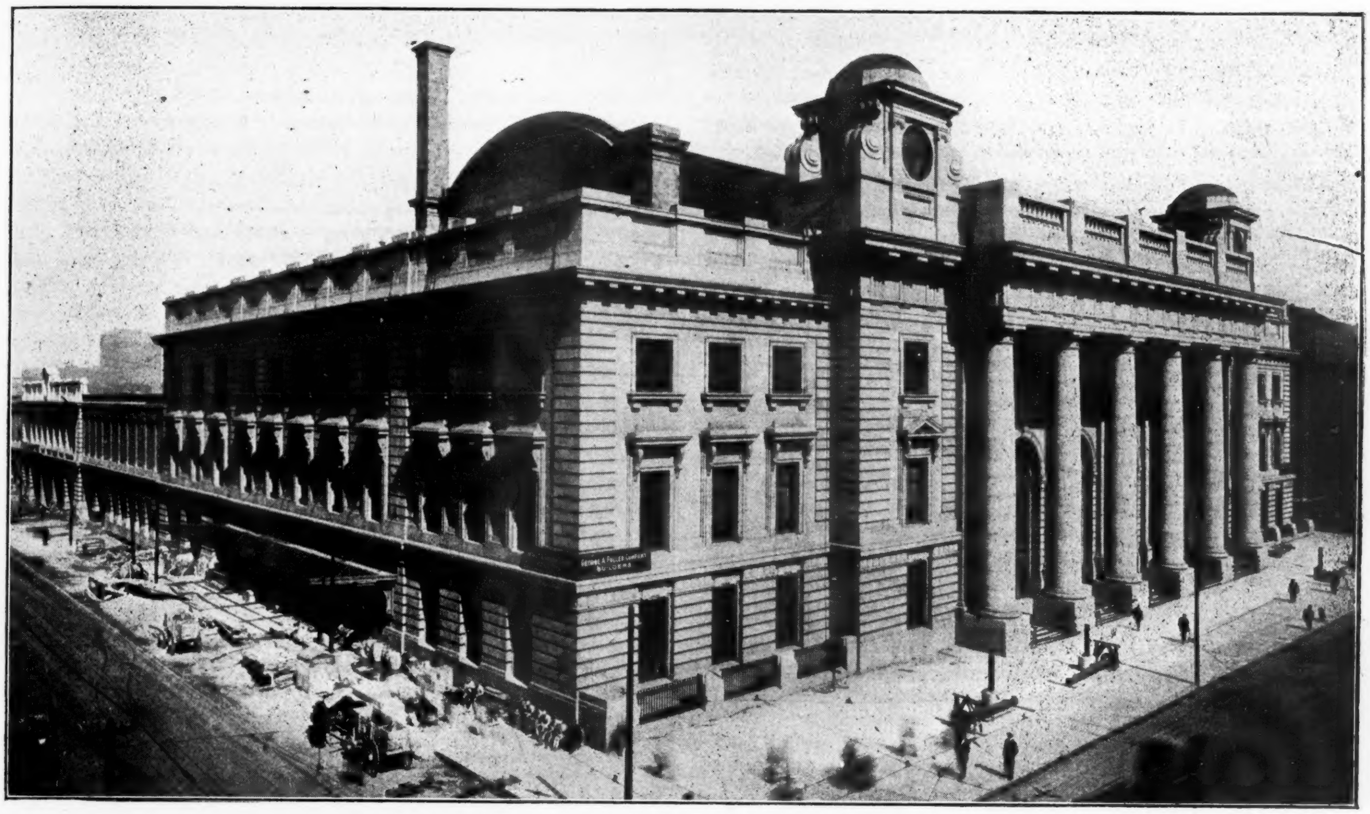
The train shed is of the Bush type, consisting of a connected series of arched girder spans, spanning two tracks and brought down close to the smoke stacks of the locomotives, with a smoke duct running the full length of the shed over each track. (Railway Age Gazette, July 16, 1909, and March 17, 1910).

The power station for light, heat and power is on a triangular piece of ground bounded by Lake street, Clinton street and Milwaukee avenue. It is of mottled gray brick, matching the train shed enclosing walls, with a granite base 6 feet high. The equipment in the power plant was described in the Railway Age Gazette of July 15, 1910.

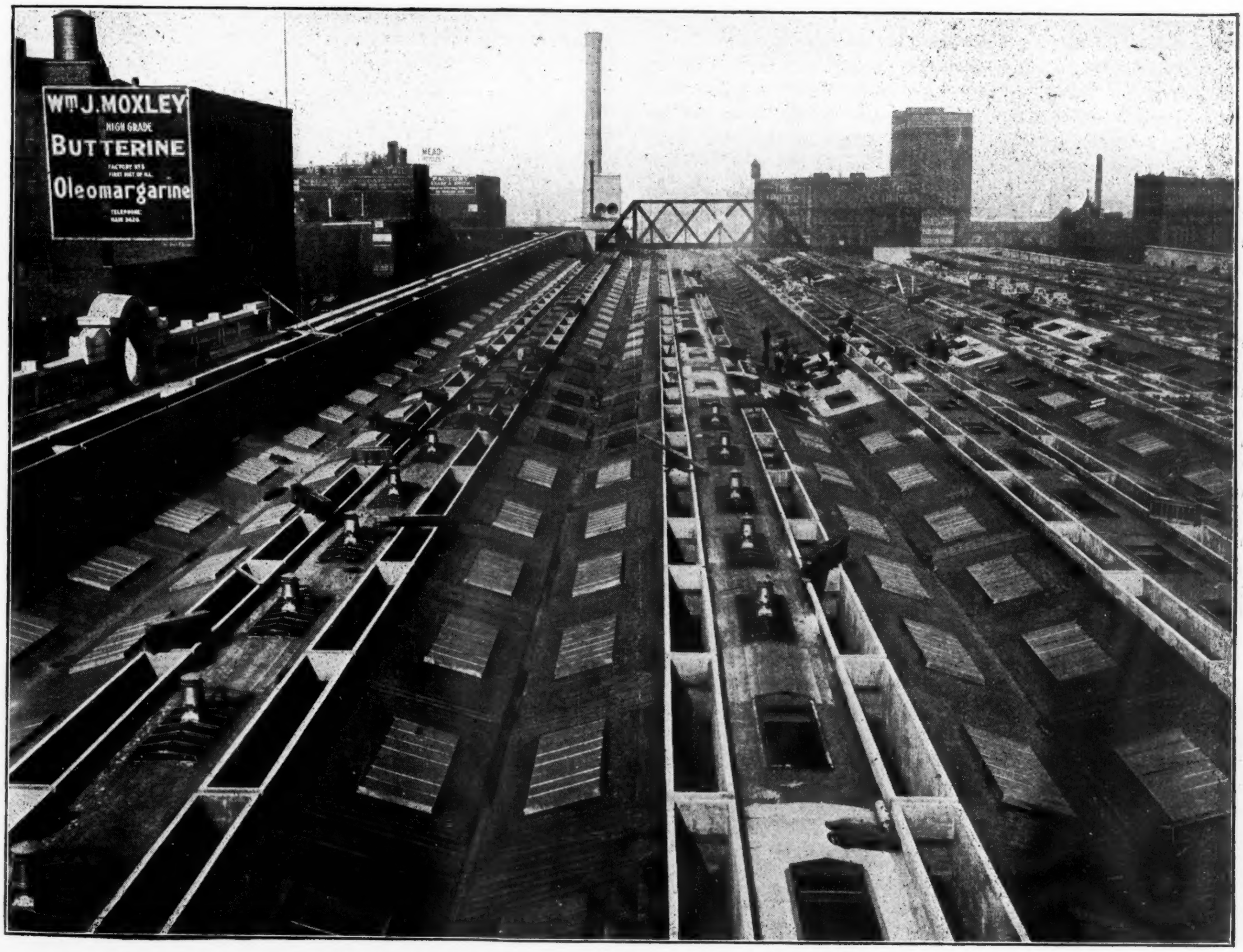
A comprehensive system of electric lighting has been provided for the terminal, one feature of which includes a projector over the entrance to the Washington boulevard subway on the Canal street side, from which a vertical beam of light will be thrown into the air, making the terminal location conspicuous at night. Complete elevator, telephone and fire alarm systems have been provided and a special system for snow melting has been installed. A pneumatic tube system connecting the incoming and outgoing baggage rooms has been installed. The tubes are oval or elliptical in shape, 3 in. by 6 in., and the cartridges are 9 in. in length. in length.

The approaches to the terminal station and the terminal station tracks north of Lake street are laid on sand filling between concrete retaining walls, being carried across the street on concrete trough floor steel viaducts resting on concrete abutments and center piers.

Preliminary studies on the general plan were begun in December, 1905. Work was started on the detail plans in the following November and the wrecking of the buildings on the site was begun at the same time. The first construction work was started on October 27, 1908. Some difficulties were



New Chicago & North Western Station Building at Chicago.



Looking North Over Train Shed from Station Building.

met in sinking wells, when fine running sand and water were encountered, making it necessary to use compressed air and requiring the sinking of the wells to rock. These wells were filled with concrete, the last one being completed June 1, 1909. Cast base setting for the steel work was started in the latter part of March, 1909, and th work of setting the foundation girders commenced the first week of April, 1909. The last steel was placed in position on March 22, 1910. Granite setting commenced the second week in May, 1909, and was completed on April 16, 1910.

In the train shed, pile driving for the foundation was commenced on October 1, 1908. Thirty-six caissons, each 6 ft. in diameter, were sunk under the approach to the Washington boulevard subway and were completed June 18, 1909. Pile driving for the foundation of the powerhouse was started August 6, 1909, being completed October 4, 1909, and was followed immediately by the concrete capping and the construction of the retaining walls. Brick-laying commenced February 1, 1910.

At the present time almost all the work has been completed except the installation of signals and some finishing on the interior of the building. This work is being rushed as much as possible, and it is expected that the station will be open for service within a few months, although no definite date has as yet been set.

COMMITTEE ON SIGNALING OF THE AMERICAN ELECTRIC RAILWAY ASSOCIATION.

The committee appointed by the American Electric Railway Association to investigate and make a report on signaling systems for interurban railways met at the Congress Hotel at 9 o'clock Wednesday morning, March 22, 1911. Representatives of seven signal companies were present, and arrangements were made for them to present the claims of their various systems at stated times during the day. The committee asked for suggestions as to the best method of procedure in its study of the principles involved, and Frank Rhea, of the General Electric Co.; L. F. Howard, of the Union Switch and Signal Co., and W. K. Howe and M. R. Briney, of the General Railway Signal Co., offered some excellent ideas.

It was the consensus of opinion in the meeting, as it is elsewhere among engineers and railway officers who are interested in the subject, that the proper course for electric railways to pursue in signaling their lines is to cover the dangerous points first with apparatus so designed that it will form a basis for future extension and an ultimate complete and comprehensive system of protection. The committee occupies a peculiar position, and its work is going to be very important in the development of protective measures. The problems to be solved are in the main the same that have been so well handled by steam road signal engineers, but they differ in many minor particulars which only a thorough knowledge of operating requirements can reconcile with the technical necessities involved.

As was said in the meeting, the first thing to do is to prepare a plan of the situation to be signaled, and then the proper protection can be applied. The committee's "data sheets," which are being sent to all electric railways, are doing this in a general way, and will give the association information regarding practically all of the important conditions which will be dealt with in its work.

TWO-DAY MEETING OF SIGNAL ASSOCIATION.

The Railway Signal Association is planning to make the meeting which will be held in New York City during June this year a two-day meeting.

IMPACT TESTS ON REINFORCED CONCRETE TRESTLE.

By J. H. Prior, Assistant Engineer, C. M. & St. P.

Some tests to determine the amount of impact on a trestle of reinforced concrete under train loads have recently been completed by the Chicago, Milwaukee & St. Paul, under the direction of C. F. Loweth, chief engineer. The tests were made on the reinforced concrete trestle, shown in Fig. 2 and Fig. 4, by R. L. Stevens, assisted by an instructor from the University of Wisconsin, experienced in such work.

An examination of Fig. 4 shows the trestle to consist of two beams supporting the slab, forming a double T-beam. The total depth of this beam is 3 ft. 6 in., but if the parapets are considered as part of the beam this depth is increased to 5 ft. 4 in. As the span is only 16 ft. center to center of piers, the concrete beam has a large ratio of depth to span. Some unexpected difficulties were encountered in this work, due to this ratio of depth to span, and also to the fact that the girders are practically continuous over the supports.

The information mostly sought in these tests was the unit stress in the steel, due to the total loads on the structure, including impact, as this information is of fundamental importance in the design of similar structures. On account of the great depth of span compared with its length, and the partial continuity of the beam over the supports, which had been only partly relied on in the design, the unit stresses in the steel were low and the consequent distortions were so small that errors of the smallest magnitude affected the results by large percentages. On account of this, the results as a whole are somewhat unsatisfactory, but are thought worthy of publication in order to mark out a little progress in the subject and save others from traversing the same ground.

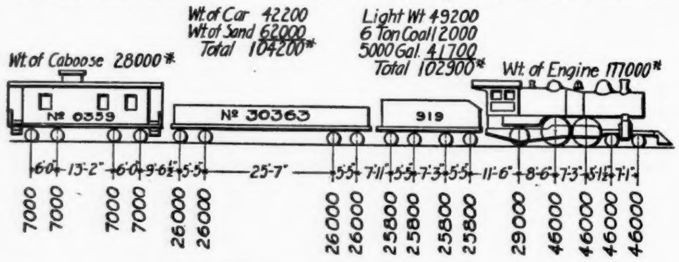


Fig. 1. Test Train.

Table 1 gives most of the important results of the tests. The following is a description of the manner in which these results were obtained: The test train, shown in Fig. 1, consisting of the railway company's class A-2 engine, one gondola car, loaded with sand, and a caboose, was used for making the test. The trestle spans were designed for an E-50 loading, but the above train was equivalent only to about E-35 loading. An engine class A-2 was selected because in this type, which is a four-cylinder compound, the unbalanced weights on the drivers are rather excessive and were expected to produce greater impact than other classes of locomotives. A marker was placed on one driver so that the location of the counter-weight might be determined for the various runs.

Table I. Summary of Results, Showing Percentage of Impact.

(1) Speed m. p. h.	(2) Extensometer No. 9. Engine. Per Cent.	(3) Extensometer No. 9. Car. Per Cent.	(4) Extensometer No. 10. Engine. Per Cent.	(5) Extensometer No. 10. Car. Per Cent.	(6) Extensometer No. 11. Engine. Per Cent.	(7) Extensometer No. 11. Car. Per Cent.	(8) Extensometer No. 12. Engine. Per Cent.	(9) Extensometer No. 12. Car. Per Cent.
8								
20	16	41	14	25	15	54	18	32
45	16	32	14	31	18	24	20	21
50	33	32	36	40	33	24	45	27
60	41	38	46	31	42	39	54	27
21	14	29	19		15	42	12	18
63.5	38	46	27	87	18	30	33	18

The four extensometers and the deflectometer used in the tests were loaned by the University of Wisconsin. The tests were conducted in a manner similar to those made by the American Railway Engineering and Maintenance of Way As-

sociation. (See Bulletin No. 125, American Railway Engineering and Maintenance of Way Association, July, 1910.) The four extensometers were attached to the bars, which had been built into the girder, so as to project a short distance, as shown in Fig. 2. One extensometer was located on the side of each girder. The projecting bars are located in the same plane as the lowest reinforcing steel in the girders, so that the deformations measured were the actual deformations of the steel reinforcement. The deflectometer was attached near the center of one of the girders. The deflections were so slight, however, that no records of any value were obtained from this instrument, consequently no results from it are mentioned in this report.

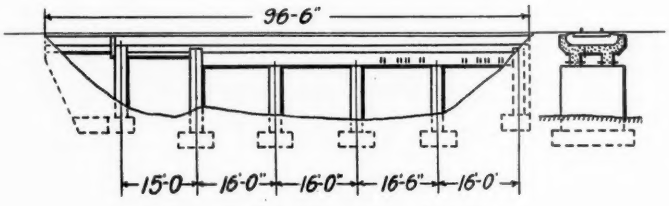


Fig. 2. American Plan of Bridge.

In Fig. 5 are shown some diagrams obtained from the extensometer to a scale enlarged two times. The "ordinates measured," which are shown in column 2 of table 2, were obtained from these diagrams by scaling on the diagram the distance between the curve and a base line drawn to connect the zero stress ends of the curves. An examination of these diagrams shows the presence of some lost motion, due either to the projecting bar, or to the imperfection of the extensometer. On account of the small amount of the distortions, this lost motion, if not corrected, would introduce a substantial error. The amount of this lost motion was determined as follows:

A theoretical investigation of the properties of the section of the spans tested, comprising the girders, floor slab and parapet, showed that if all were assumed to act together, the section has a resisting moment in inch-pounds of 1,081 times the unit stress in the steel in the lower portion of the beam. For the test train this gives a unit stress in the reinforcing steel of but 680 lbs. per square inch, and 65 lbs. per square inch tension in the concrete at the top of the parapet wall over the piers. On this same assumption, for a full E-50 loading, impact and dead load, the corresponding stresses are 3,960 lbs. per square inch in the steel and 344 lbs. in the concrete. Since this bridge has never in its lifetime been loaded to this amount, it seems justifiable to assume that the concrete on the tension side has never been ruptured, and therefore that the entire section acts effectively to resist bending.

Using the above assumptions, there is shown in the 4th and 5th columns of table 3 the calculated stress in the steel for the test train with its corresponding ordinates. These ordinates were assumed to be correct for static loads.

Table II.

Extensometer No. 9.

(1) Speed m. p. h.	(2) Ordinate Measured, Inches.	(3) Ordinate Corrected, Inches.	(4) Static Corrected, Inches.	(5) Excess Over Static, Inches.	(6) Excess Impact, Per Cent.
8	0.012	0.073	0.073		
20	0.024	0.085	0.073	0.012	16
45	0.024	0.085	0.073	0.012	16
50	0.036	0.097	0.073	0.024	33
60	0.042	0.103	0.073	0.030	41
21	0.022	0.083	0.073	0.010	14
63.5	0.040	0.101	0.073	0.028	38

It is reasonable to assume that the error of lost motion mentioned is a constant, and that it affects all of the "ordinates measured," column 2, table 2, by the same amount.

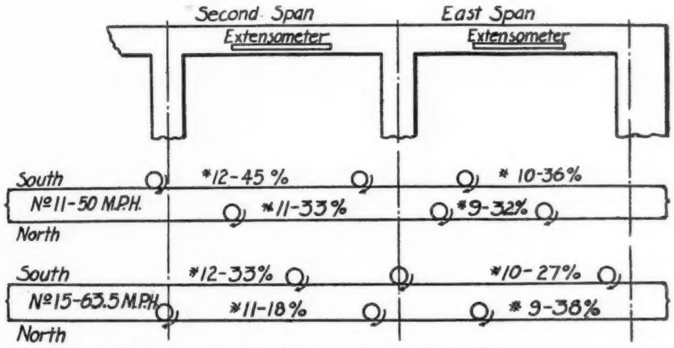
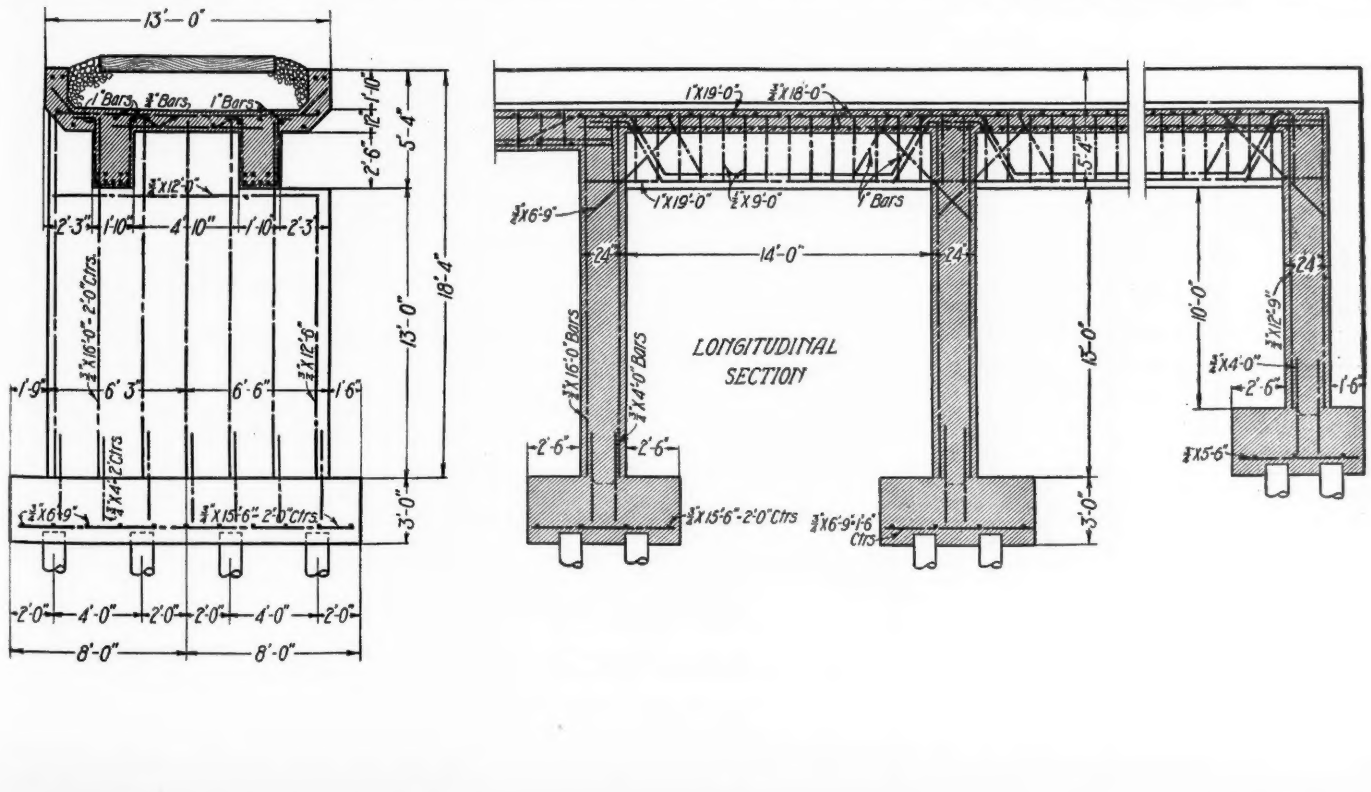


Fig. 3. Location of Extensometers and Position of Counterbalances.

If these "ordinates measured" contain a constant error, this constant error will be eliminated whenever we are considering the differences between two "measured ordinates." Now it is known that for speeds of 8 miles per hour the impact is practically nothing, and that the difference between "measured ordinate" for 8 miles per hour and the "measured ordinate" for 20 miles per hour gives the increase in ordinate, due to impact at 20 miles per hour. The difference between the "measured ordinates" for speed of 8 miles per hour and



the "measured ordinates" for speed of 20 miles per hour in table 2 is .012. This difference, divided by the total calculated ordinate for instrument No. 9 in column 5, table 3, is .2, which, if our assumptions are right, would show an impact of 20 per cent. for a speed of 20 miles per hour. The value of 20 per cent. just calculated was obtained from a reading of only one instrument, extensometer No. 9. The records of two other instruments, not shown, give values of 15 per cent. and 18 per cent. The values given by the 4th instrument are divergent, but can be accounted for by the irregular character of the quantity measured. Of these values, an impact of 15 per cent. was selected because it agrees in a reasonable way with the values obtained for a speed of 20 miles per hour in a large number of experiments on steel structures. (Bulletin No. 125, previously quoted.) When the impact for 20 miles per hour has been determined, it is an easy matter to make an approximation of the lost motion and to correct the "measured ordinate" by the calculated lost motion, so as to obtain the values in the third column of table 2, called "ordinate corrected." This "ordinate corrected" is obtained by the following equation, in which, in the first member of the equation, "a" is the corrected ordinate, and where values in the second member of the equation are the second, sixth and first items in column 2 of table 2:

Table III.

(1) No. of Extensometer.	Extensometer. (2) Lever Ratio.	(3) Length of Rod "L," Feet.	Calculated Stresses. (4) Stress, Pounds.	(5) Ordinate, Inches.	Static Ordinates. "Corrected." (6) Ordinate, Inches.	(7) Stress, Pounds.
9	47.0	4.38	680	0.059	0.073	840
10	47.2	4.40	680	0.059	0.073	840
11	52.5	4.35	680	0.066	0.067	690
12	48.5	4.25	680	0.061	0.133	1,480

$$115 \text{ per cent. } a - 100 \text{ per cent. } a = \tfrac{1}{2}\ (.024 + .022) - .12$$
$$15 \text{ per cent. } a = .011$$
$$a = .073$$

From the above we get "calculated ordinate" for speed of 8 miles per hour, .073. "Measured ordinate" for speed of 8 miles per hour is .012, in the second column of table 2. Their difference is the constant error, .073 — .012 = .061. If the constant error thus determined is added to the "measured ordinates" in column 2, table 2, we obtain column 3, table 2, marked "ordinate corrected."

The difference between the ordinates corrected of column 3, table 2, and the "static corrected," column 4, is the "excess over static," column 5. The values in column 5, divided by the values in column 4, give the percentage of impact, column 6.

Column 6 of table 2 is the 2nd column of table 1. The other columns of the "Summary of Results," table 1, were obtained in same manner from tables similar to table 2, but not shown in this report. The "corrected static ordinates" for the extensometers 10, 11 and 12, obtained in a similar manner to extensometer No. 9 of table 2, are shown in the 6th column of table 3, where they are compared with the calculated ordinate shown in the 5th column of the same table. Considering the small quantities involved, the agreement is fair and seems to justify the assumptions made.

Incidentally table 3 shows that the structure does not receive anything like the stresses for which it was designed. The longitudinal joint "c," Fig. 4, between the slab and the parapet wall, which it was thought inadvisable to count in the design for transmitting longitudinal shear, seems to be entirely effective for that purpose, making the entire span a monolith, and suggests that possibly the design of the parapet walls of similar slabs might be modified so that there might be no doubt as to the ability to carry the stresses, which they unquestionably receive.

The location of the counter-balances on the locomotives in their lowest position with regard to the center of the span is shown by diagram in Fig. 3 for two runs. These runs are typical of the others, and from them it does not seem that the location of the counter-weight in its lowest position with regard to the center of the span had influenced particularly the amount of impact obtained. However, as the structure consists of five spans fully continuous and integral with the piers, it is hardly expected that the effect of the counterweights would be as clearly defined as in simple spans, although the unbalanced weights may be just as effective in producing impact, especially if the span had been the ordinary shallow slab, not built in place.

As shown in table 1, the maximum impact obtained under the engine was between 50 and 60 per cent., although the number of observations made was hardly sufficient to warrant the conclusions that no higher values might be expected.

As a fund of definite information on this subject is of economic value in the design of reinforced concrete structures, the subject seems to be worthy of further study and investigation, and Mr. Loweth has at present in mind some further tests to be made on shallower and longer spans, if possible.

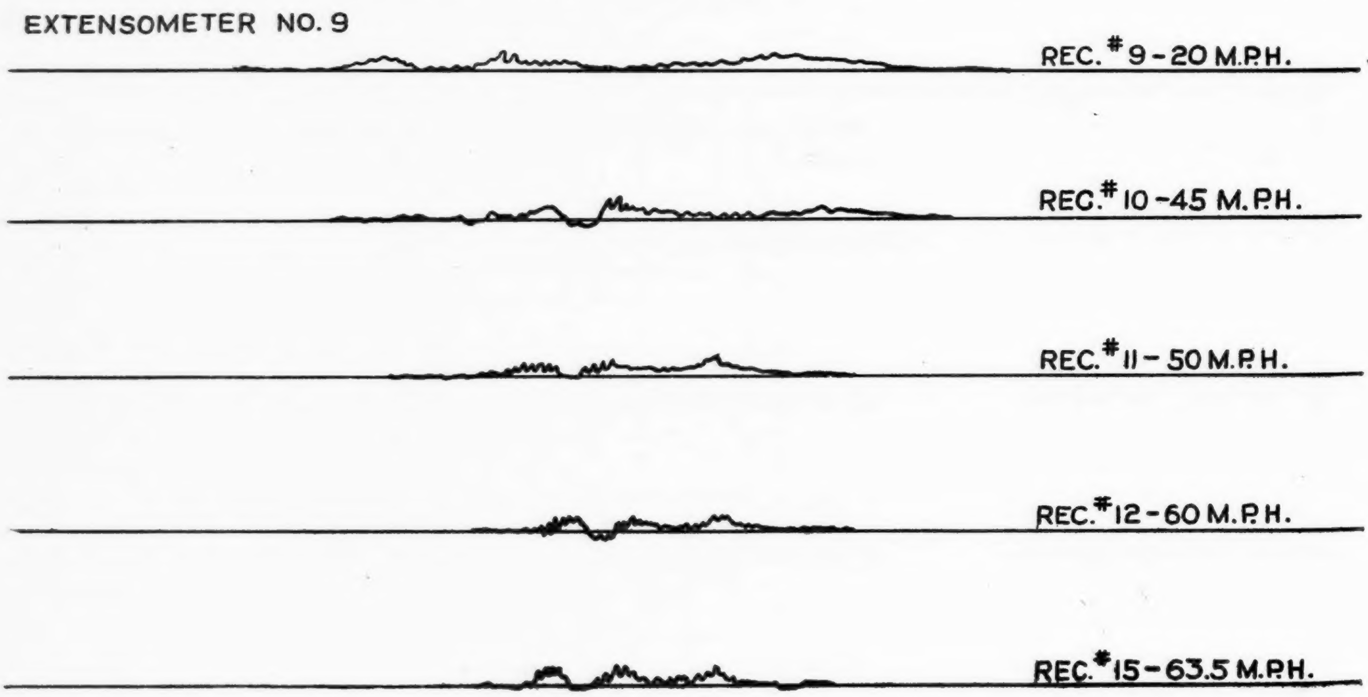


Fig. 5. Extensometer Diagrams.

REGISTRATION—MAINTENANCE OF WAY ASSOCIATION

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Entwisle, E. D., Ch. Eng., J. & S. C. R. R., Johnstown, Pa.

At the Coliseum

It has been decided that no space for the 1912 exhibit will be given out by the secretary or by the executive committee of the Railway Appliances Association before the first day of November, 1911.

One exhibit that is attracting attention from railway men are the four sample boards of lead covered "Okonite" signal cables. These boards show the 139 different styles of cable recently manufactured by The Okonite Company, New York, for a large railway terminal in Chicago.

Visitors to the exhibit of the Adams & Westlake Company, Chicago, have been much interested in the significance of the "flush" over the south entrance to the spaces. The "flush" appears on the face of one of the standard engine indicating lamps made by this company, which forms a small part of its exhibit of standard and special railway lamps and lanterns.

The exhibit of the Universal Metallic Tie Company, Salt Lake City, Utah, at Booth 207 in the Coliseum, in charge of J. W. Johnson, secretary, and B. S. Rupp, manager of contracts and construction, is attracting much attention from railway men. The features of the Universal Metallic include the absence of spikes, tie plates, rail anchors and rail braces. These ties are now in service in Chicago in the main line of the Santa Fe, near Twenty-first street, and in the line of the Chicago, Burlington & Quincy, near Western avenue, where they may be seen by visiting engineers.

Methods of instruction in signal departments are receiving the attention of signal engineers pretty generally throughout the country, especially since signaling has come to occupy such an important position in railway operation; and many signal engineers are turning their attention to improvements in the methods of instructing their signalmen, or to establishing systems of instruction where none has been in use before. One of the signal companies has anticipated this in a nice way by getting up sets of model signals which can be used for instruction purposes, and is showing these signals at the Coliseum.

The following completes the list of exhibits published in The Daily of March 21:

Andresen-Evans Company, Chicago, Ill.—Grab buckets. Represented by D. J. Evans, R. B. Randall, F. V. Carroll and F. E. Mather. Space 215A.

Columbia Nut & Bolt Company, Bridgeport, Conn.—Lock Nuts. Fred Atwater, H. N. Powers and J. N. Eipper. Space 19.

M. & S. Steel Company, Munhall, Pa.—Steel tie. Represented by W. W. Mechling. Space 171A.

Williams Company, G. H., Cleveland, Ohio.—Grab buckets. Represented by G. H. Williams. Space 112.

The Hobart-Allfree Company, Chicago, space 17, is showing its standard derailers, the Freeland mechanical-throw, and the Smyth hand-throw. These derailers are made with a lip which fits over the head of the rail, taking all the side thrusts caused by a derailment and relieving the supporting brackets of the strain which would otherwise be put upon them. The derailing blocks which fit over the rail are specially designed for effective work. The Smyth derailers, which are operated by hand, vary from four ft. to 20 in. in the length of the derailing block, while the type of Freeland derailers, which is for operation by hand, is made in one model only, 2 ft. 8 in. long. The Freeland types designed for mechanical throw are furnished in three models which have

the same general design, but vary in the lengths of the derailing blocks. The company has recently had its derailers tested on a number of Eastern lines, and reports that the tests have been successful in every case. One road in particular has tested these devices with a view to their adoption as standard; and it was announced to the members of the company in charge of the exhibit that the tests have been exceedingly satisfactory. The derailers also have many friends in the West, and their use in that part of the country is constantly on the increase. The Hobart-Allfree Company is represented in the East by the L. S. Brach Supply Company, New York, which reports a very satisfactory business in the derailers.

The question of securely anchoring rails so as to prevent their longitudinal creeping, especially at crossings, switches, and in and about interlocking plants, is one of great importance to both the maintenance of way engineer and the signal engineer, and inventors have been almost as prolific along this line as in devising nut locks. Many good rail anchors are now on the market, and it would seem that most of them are now on exhibition at the Coliseum. At any rate the "old reliables" which have been giving good service for a long time are there, and there are some others which are newer, perhaps, but nevertheless are built upon such good principles and are so ingenious in their construction that they would seem to be worthy competitors of the older types.

The development of the caustic soda primary battery is a matter of only a comparatively few years; but this type of cell has been brought up to such a high standard of efficiency and is now applicable to so many conditions that it can be considered as practically perfected. It is interesting to look back over the different stages through which the primary cell has passed in its very rapid growth. The Edison Manufacturing Company, Orange, N. J., has a very effective representation of this remarkable development in its exhibit, space 151, in which are shown sample plates of every type that this company has ever manufactured during the evolution of its cell, together with a full line of the latest types. The exhibit is in charge of E. E. Hudson, F. W. Brown, F. J. Lepreau and Phil. Garrity.

STYLE C ELECTRIC SWITCH-AND-LOCK MOVEMENT.

The style C electric switch and lock movement, made by the Union Switch & Signal Company, Swissvale, Pa., requires small space, is entirely enclosed in a cast-iron box, and can be secured to three ties of ordinary spacing. The slide bar and escapement crank are similar to the standard mechanical switch-and-lock movement, except that the escapement crank has arms of equal length. The movement is driven by a motor through a train of reduction gears and a screw shaft and floating nut. The signal circuit controller depends not alone upon the position of the movement, but also on the correct position of the points themselves, the lower contacts being mechanically connected to the switch point so that the opening of the switch one-eighth of an inch will break all of the signal circuits.

THE CRANE COMPANY'S EXHIBIT.

The exhibit of valves, which the Crane Company, Chicago, has in space 146 at the Coliseum, is something which every railway man engaged in work where such products are required should make it a point to see. There are valves for almost every conceivable purpose connected with railway operation, including locomotive blow-off valves, operable from the cab at any time whether the engine is runnig or standing still, hose valves warranted never to leak, hydraulic valves for pressures up to 2,500 lbs., locomotives pop valves, creosoting valves, motor-operated gate valves, improved pop safety valves for all kinds of steam boilers, and still other types for many different purposes. The exhibit also includes pipes and pipe-bends, and a working model of the Cranetilt direct-return and non-return steam traps. The exhibit is in charge of F. D. Fenn, manager of the railroad sales department; S. B. Sabin, manager of the specialty department, and J. V. Jordan.

WHARTON TRACK WORK.

The exhibit of Wm. Wharton Jr. & Co., Inc., Philadelphia, Pa., includes a solid manganese steel single frog, in addition to manganese steel center frogs of different types. One of the frogs of the latter type was in the track under service for a number of years and then restored to a condition as good as new. There is also a Wharton railway switch of improved type, besides a manganese steel-faced guard rail, switch stands, the company's new rail anchor, the Wharton guard rail clamp and models of movable point crossings, with manganese steel parts, etc.

One of the recent jobs made entirely out of manganese steel that the Wharton company has turned out is a solid manganese steel double crossover, which was made for the Central of New Jersey. Unfortunately, circumstances were such that it was necessary to install this piece of work immediately upon completion, making it impossible to exhibit even a part of it, but photographs and prints in the Wharton space will give an idea of the extent of the job and the size of the manganese steel castings. The company claims that this is the first job of the kind ever attempted by any manufacturer on account of the difficulty in making castings of the size required. The Wharton company occupies spaces 9, 10, 27, 28 and 29.

A STEEL TIE AND FASTENINGS.

The American Railway Steel Tie Company, Harrisburg, Pa., is showing, in spaces 220 and 221, a variety of improved fastenings for steel and wood ties, and a steel tie which is one of the most interesting, to say the least, of the many improved ties now on the market. The fastenings are designed to prevent the mechanical wear or abrasion of the ties under the rails, and they embody a plate which is placed between the rail and the tie, and adjustable clips or clamps which hold the plate to the base of the rail. These clips are held to the plates in such a way that there is no tendency for them to work loose. In other words, when they are once in place they "stay put." They furnish an adjustment by which it is possible to keep the rails to gauge at all times, and also to avoid the destructive effects of spikes when they are used with wooden ties. The steel tie made by this company consists of a steel shell with flanges so arranged that it is perfectly feasible to tamp the tie properly, as the round corners make it easy for the tamping bar to get underneath the body of the tie. The shell is filled with a mixture of asphalt and stone. These ties are provided with the adjustable clips and locking plates. They are made in the standard length, and the weight of the tie complete, when filled with this mixture, is about 600 lbs. Maintenance of way engineers cannot fail to be impressed with the fact that the type of construction offered by this tie gives many advantages of strength and solidity which cannot be secured with wooden ties. If it is desirable, however, to use wooden ties, the adjustable clips and locking plates furnish a way to do this and still make the ties last much longer than they

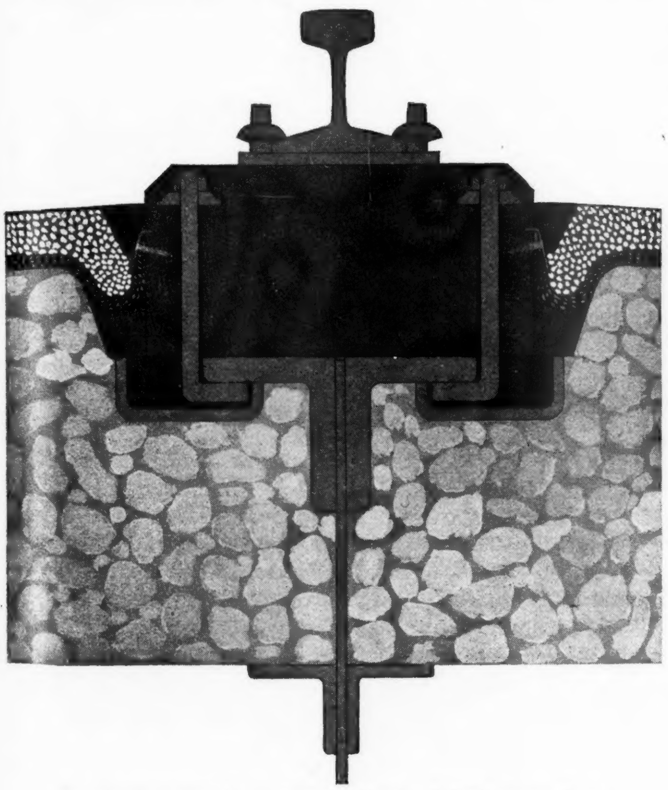
would if the ordinary spikes were used. The exhibit is being conducted under the direction of John G. Snyder, vice-president of the company.

WATERPROOFING WORK IN THE CHICAGO & NORTH WESTERN TRAIN SHED AT CHICAGO.

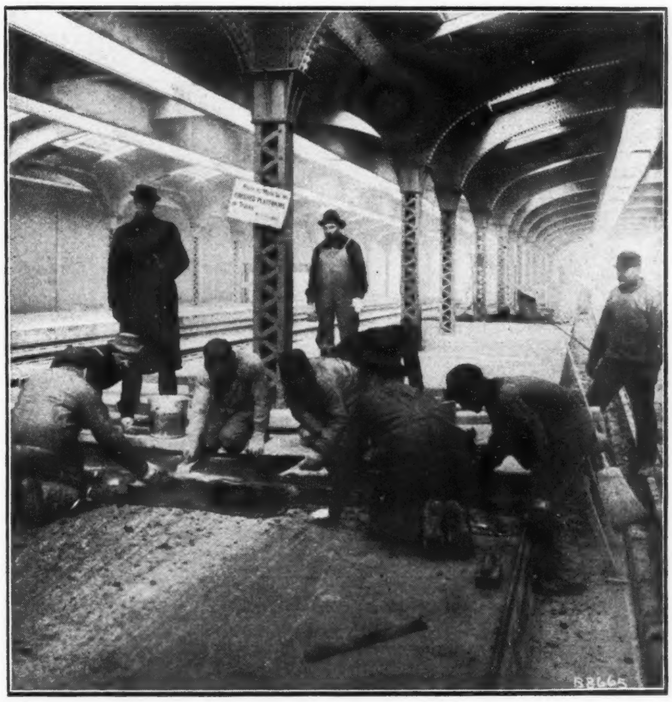
The accompanying cuts show the train shed of the Chicago & North Western at Chicago, while waterproofing work was in progress, and a cross section of the track construction and the method of waterproofing along the wooden stringer carrying the rail.

In the cut of the train shed, the rock asphalt layers are shown in the act of placing the mastic wearing surface on the concrete platforms. In a similar manner, mastic protection was placed over the waterproof membrane between rails, as defined in the cut of the cross-section. The mastic was carried up to within 1½ in. of the stringer and an opening provided by means of oiled strips which were removed after the mastic hardened and the opening them filled with Sarco No. 6 waterproofing, which provided a seal along the wood stringer.

The critical point in this waterproofing work was naturally along the edge of the stringer. While the stringer rested directly on a longtitudinal girder which was as solid a foundation as was possible, it was expected that there would be a slight weave throughout the length of the stringer from engine loads; so to provide against the slightest hair crack, it was deemed necessary to keep the mastic protection away from the wood and introduce an elastic and adhesive seal which would follow the slight movement in the stringer without opening up. As there were nearly 60,000 lineal feet all told, or nearly 12 miles of this construction involved, the possibility of leakage was enormous. Not satisfied even with this precaution, and to make assurance doubly sure, the waterproof membrane, which in this case consisted of Sarco No. 6 waterproofing reinforced with open mesh burlap in three-ply, was securely tied in to the stringer by means of metal flashing driven into the wood. This metal flashing was held firmly in position by the friction of the wood on the driven leg of the flashing, and still further secured by 1¾ in. wood drive-screws spaced 12 in. on centers. This provides an effective mechanical seal and, along with the natural seal provided by the Sarco No. 6 waterproofing, effectively prevents any water working down along the sides of the stringer.



Track Construction and Method of Waterproofing.



Waterproofing the Chicago & North Western Train Shed, Chicago.

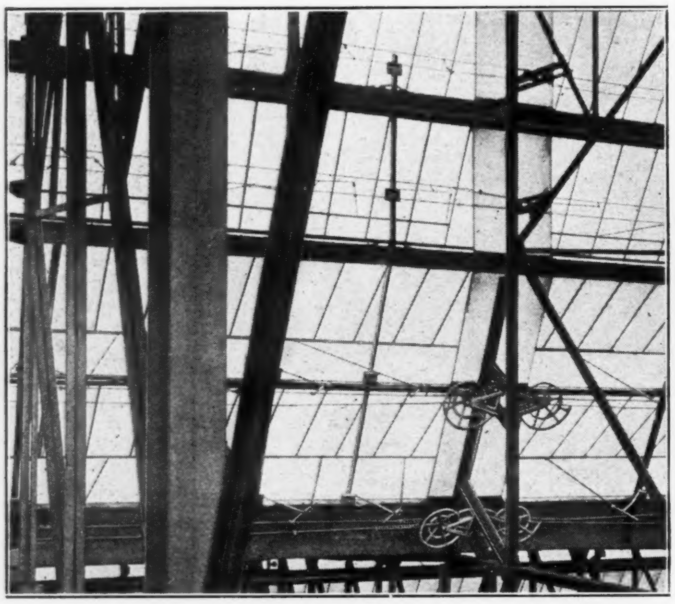
The cast iron pockets for the hook bolts which were set in the concrete flush with the top flange of the girder, were filled completely with Sarco No. 6 waterproofing, which was poured into the bolt holes and worked its way down along the bolts, thoroughly sealing up these openings and at the same time affording protection to the metal.

While the general method of waterproofing construction employed in this work is well known and practically standardized by its extensive use on many railways, the construction details were entirely new and original and were developed by the railway and waterproofing department of the Standard Asphalt & Rubber Co., Chicago, especially to meet the difficult conditions imposed.

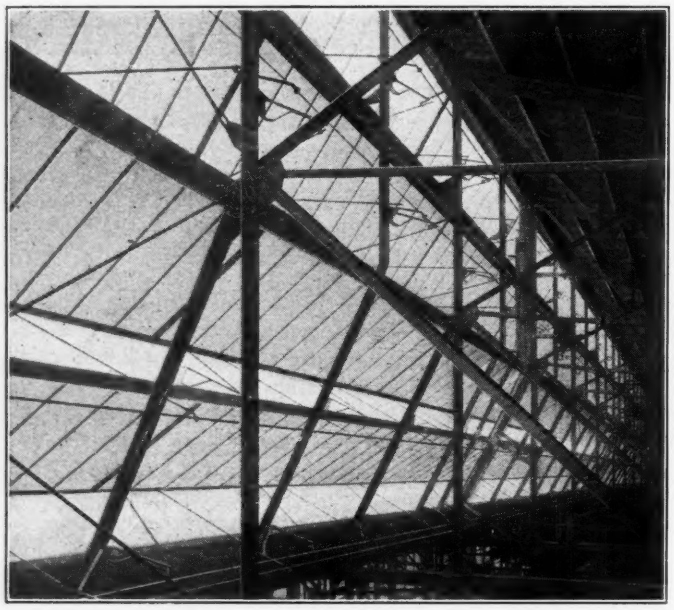
POND SASH OPERATING DEVICE.

The cuts illustrate the interior view of one side of the monitor on Deere & Co.'s forge shop at Moline, Ill., on which the Pond operating device and Pond continuous sash were used. The Pond truss is a new type, designed particularly for lighting and ventilating forge shops and foundry buildings. It is used on buildings 50 ft. to 170 ft. wide, of single monitor construction. Each side of the monitor is equipped with two lines of vertical and two lines of sash, inclined 30 degrees, as shown. As the center line of columns in the building and the roof of monitor slopes toward the center to down-spouts which attach to the main column, this form of construction deflects the gases toward the sash, and the height of the building provides better ventilation and ideal lighting conditions. On account of the heavy load of sash on the sloping section of the monitor, spirals are used to offset

the varying load, as illustrated, exactly counterbalancing the varying load of sash. Large photographs and complete details are shown in Space 54 at the Coliseum, fully illustrating the lifts and other installations of Lupton steel sash, Pond continuous sash, Pond operating device and Lupton



Pond Operating Device and Pond Continuous Sash.



Pond Continuous Sash and Operating Device.

rolled steel skylights, manufactured exclusively by David Lupton's Sons Company, Philadelphia, Pa.

AMERICAN INGOT IRON CULVERTS.

On the electric railway being built from Kansas City, Mo., to St. Louis one of the most serious problems confronting the engineers in charge was the culvert proposition. A series of exhaustive tests were made on all forms of culvert construction and the results obtained from these tests justified the engineers in recommending the use of American ingot iron corrugated culverts for the entire work.

The cuts herewith show one of the severe service tests made on this form of culvert construction. Fig. 1 shows a 36-in. pipe and a 48-in. pipe lying side by side and placed directly under the ties. This, of course, is a more severe condition than the culverts would encounter in actual service; but it proved conclusively the strength of this form of culvert construction. Fig. 2 shows a 90-ton engine placed directly over these culverts. The deflection was less than ¼ in. This test convinced the engineers of the strength of these culverts.

By carefully analyzing the plates used in the construction of these corrugated culverts, it was found they were

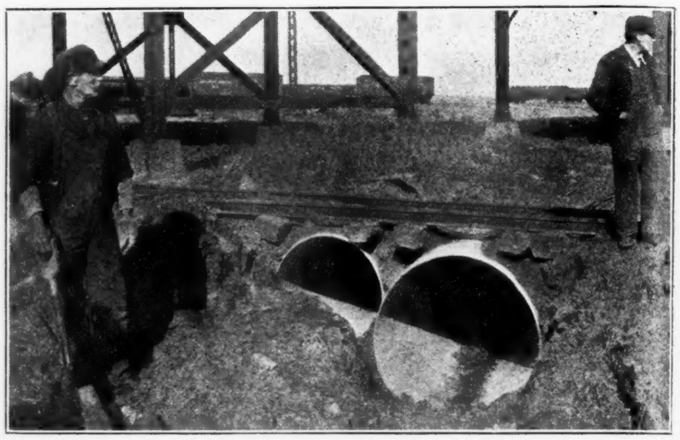


Fig. 1. American Ingot Iron Culverts in Loose Sand, for Test. St. Louis-Kansas City Electric Railroad.

made from iron which is almost chemically pure, the analysis being as follows: Sulphur, .019 per cent.; phosphorus, .005 per cent.; carbon, .015 per cent.; manganese, trace; silicon, trace. Material of that composition will last a lifetime.

In consideration of the excellent results obtained in both

Fig. 2. St. Louis-Kansas City Electric Railroad Test of American Ingot Iron Culverts.

the strength and chemical tests, the St. Louis-Kansas City Electric Railroad has decided to use American ingot iron culverts for all its culverts, ranging from 12 in. to 48 in., inclusive. The actual order placed amounted to over 30,000 ft. of culvert pipe. The engineers in charge highly recommended American ingot iron culverts because they are strong, durable and easy to install, and, last, but by no means least, they reduce the cost of construction.

SOME CAUSES OF CREEPING RAILS AND ONE METHOD OF MEETING THEM.

Creeping rail, due to the constantly increasing weight of locomotives and rolling stock and the increasing speed and weight of trains out of proportion to the progress in roadbed and track construction, is met with in various forms. The most common instances are where heavy loads are running down grades of over 0.5 per cent. On these grades, heavy freights are constantly applying and reapplying brakes, which, in addition to the usual wave motion

of the rail, constantly grips the track and tends to drag it along with the train.

Curved track is another fertile source of creeping. Curves cannot be elevated to suit varying speeds, but must be adjusted for a speed between high and low. The result is that high speed trains grip the high rail tightly in taking the curve and have a tendency to draw the rail along with them. If a freight takes the curve at low speed, the tendency is to throw the weight on the low rail. Observation indicates that in most instances the high rail is affected a great deal more than the low.

Soft or swampy roadbed is probably the worst cause of creeping that a track man has to face. The train in passing over such a spot catches the excessive wave motion in the rail caused by the soft substructure at the highest point of the wave. This will force level and tangent track to slide more rapidly than on severe grades. Bridges and trestles often may also be considered in the same class as soft substructure, but here we have the added obstacle

Boltless P. & M. Anti-Rail Creeper in Position on Rail.

in the fact that the rail is very seldom spiked at the angle bars, which are left free to slide as they will. This, it is evident, is very troublesome in cases of draw bridges.

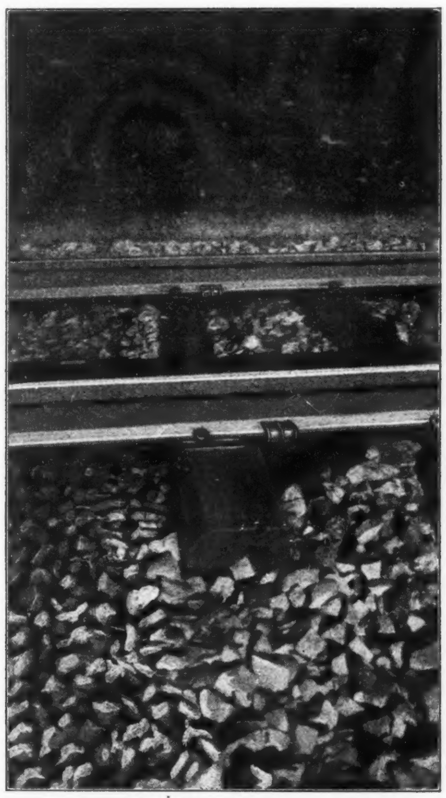
As soon as the track creeps, proper expansion spaces are lost, resulting later in kinks. With angle bars spiked in the slots and with broken joints, the joint ends of the joint ties are dragged off the tamped ballast, causing a low joint and even breaking a joint; the gage is distorted, spikes are sheared, and switches, frogs, crossings and interlocking connections are thrown completely out of line. Such a case of heavy creeping is shown in one of the accompanying illustrations.

Within the last four years there has been developed a two-piece boltless anti-rail creeper. This is the P. & M. The quantity of these anti-rail creepers applied varies with conditions; generally four to a rail is sufficient, and in some cases two to a rail. Extreme conditions, however, demand extreme remedies, and applications as high as 12 and 16 to a rail have been made in which the use of this device has saved its cost sometimes in six months and frequently in a year and a half.

The best practice in applying anchors where broken joints are used is to spike the angle bar in its slots and

Joints Driven Out of Place by Creeping Rails.

then apply the creepers on the opposite ends of the joint ties, which must then be forced bodily through the ballast. There can be no skewing and the tie moves with much more difficulty than if it were free at one end and spiked to the joint at the other. Where four anchors are desired, the other two are placed at quarters of the rail. Where



Two P. & M. Anti-Rail Creepers at the Quarters of the Rail.

additional quantities are desired per rail, they are distributed evenly along the rail length and the opposite ends of the ties are also anchored on the rail.

The P. & M. Company, Chicago, which markets this device, was formerly the Railway Specialty & Supply Company. Its interest in the device does not cease when the

sale is made. An efficient corps of instructors and inspectors is maintained at the company's expense, and these men are constantly on the road. It is their duty to see that the customers of the P. & M. Company get all possible benefit that they should get from the device. They instruct new men in its application, they see that the device fits properly and is manufactured of proper material and is the proper design. They see that the railway company applies the proper number of anti-rail creepers, not too many where the creeping is not severe and not too few where the creeping is too severe. The road may lose many of the benefits this device offers by trying to apply too few where conditions are severe. To put all the creeping pressure against one tie will cause that tie to move more easily than if the creeping pressure were distributed over several ties. Creeping pressure may even be severe enough to break the device where only one creeper is applied, whereas the application of two or four would do away with all breakage, properly distribute the creeping pressure and save the railway the cost of the device in a very short time.

The P. & M. Company has just issued Bulletin T-2111, describing the latest and most economical means of applying the P. & M. anti-rail creeper. This bulletin is issued annually and by a liberal use of half-tones shows in detail the proper way of handling the anchor. A complete exhibit of full size anchors on the rail, as well as many large photographs of the device in track at various points in this country, may be seen at Space 123 at the Coliseum.

SCHERZER ROLLING LIFT BRIDGE FOR BALTIMORE & OHIO AT CLEVELAND.

The Baltimore & Ohio has just finished and placed in service a long span bascule bridge of the Scherzer type at its crossing of the Cuyahoga river at Cleveland, known as bridge No. 402. The new bridge, which is a single leaf double track structure, replaces a single track center pier swing bridge.

Competitive designs and proposals were called for in the summer of 1909 and the contract was awarded to the Pennsylvania Steel Company in July of that year on the design submitted by the Scherzer Rolling Lift Bridge Company.

The outline of the structure is in accordance with the Scherzer standard design of single leaf through truss railroad bridge, having an inclined top chord from the counterweight box to the front end post. The moving span is 200 ft. long center to center of bearings, being the longest double track single leaf bascule bridge in the world. It is only exceeded in length by the 230 ft. span single track single leaf bridge of the Scherzer type built for the same railway at Cleveland in 1907. The trusses are spaced 30 ft. center to center, with a depth at the main post of 53 ft. and 30 ft. at the front post. In the third panel from the front end the depth of stringers is reduced 12 in. to provide that amount of additional underneath clearance for small water traffic. The moving span is counterweighted by plain concrete, with an average unit weight of 146 lbs. per cubic foot. The concrete is carried in a box of steel plates running across between the trusses and in wings in the plane of each truss. This method of counterweighting makes the counterweight an economical fixed part of the moving leaf and provides a very rigid bracing between the trusses, the entire leaf, both steel and counterweight, being one simple and substantial structure, without trunnions or flexible connections.

The bridge is operated by two alternating current electric motors, having a rated capacity of 75 h. p. each. The motors are placed on the moving leaf on a machinery platform in front of the counterweight box. The power of the motors is applied through simple gearing to shafts passing through each truss of the moving leaf at the center of roll, this point moving in the operation of the bridge

Scherzer Rolling Lift Bridge for the Baltimore & Ohio at Cleveland.

in a line parallel with the top surface of the track plates upon which the bridge rolls. Pinions attached to these shafts engage with racks placed on fixed rack supports outside of the plane of the trusses. The simplicity of this method of operation is one of the particular merits of the Scherzer type of construction. As the bridge is in balance in all positions, the power required for operation is slight, but a small part of the capacity of the motors being required under ordinary conditions. The machinery is designed so that the bridge can be operated by hand power, should the current be cut off or the electric equipment be out of service, by driving the pinons by means of chains passing over sprocket wheels on the shafts. The operating machinery is interlocked with the front lock holding the bridge in the closed position and with the railroad signals, so that the front lock cannot be withdrawn and the bridge operated until the proper railroad signals are set.

The operation of the bridge is controlled by a controller for each motor placed in the operator's house, the two controllers being so connected that they may be operated together. The operator's house, in addition to devices for the control of the electric operation of the bridge, contains indicators which show to the operator, both day and night, all positions of the bridge during operation.

The entire structure was designed and built under the supervision of W. S. Bouton, engineer of bridges of the railway. The design of the bascule span was prepared by the Scherzer Rolling Lift Bridge Company, Chicago, Albert H. Scherzer, president and chief engineer, the steel work being fabricated and erected by the Pennsylvania Steel Company, Steelton, Pa., Thomas Earle, superintendent.

ECONOMY CLAW BAR.

The Economy claw bar, illustrated herewith, is made by the Economy Separable Switch Point Company, Louisville, Ky. Fig. 1 shows the parts, and Fig. 2 the bar complete. This claw bar is made of a high grade of steel and the claws are forged separately, insuring a more perfect contour than

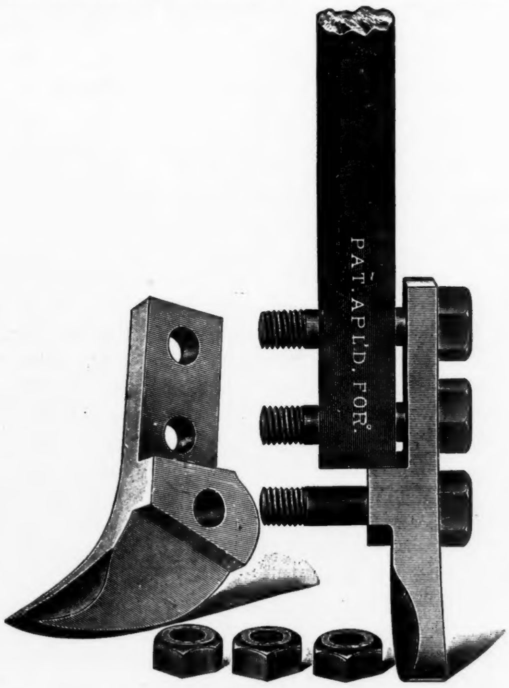


Fig. 1.

is possible when the bar is forged as a whole. The perfection of contour enables section men to fasten the claws to a spike head quickly and certainly, and the shape is such that the spike is pulled without bending, thereby saving it for use in redriving. The claws of the Economy bar come "rights and lefts," and are furnished in pairs. They weigh

Fig. 2.

2½ lbs. each, so that they can be readily carried, and thus allow the section man to insert a new one if the bar is broken.

POSITIVE RAIL ANCHOR.

The Positive rail anchor and tie plate is here shown with the rail removed so as to illustrate more clearly the tie plate feature, Fig. 1 showing a top view and Fig. 2

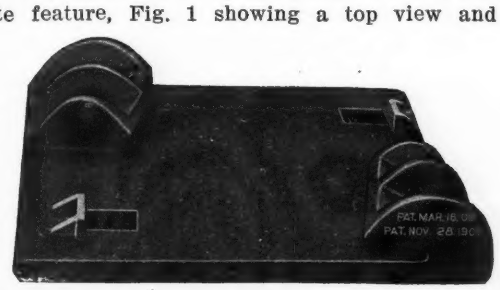


Fig. 1.

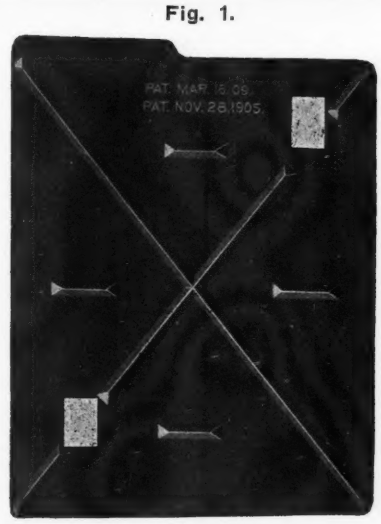


Fig. 2.

the bottom view. Attention is directed to the wedging jaw, which utilizes the wedge shape of the base of the rail instead of gripping the edge of rail base, as is the usual method in other rail anchors or anti-creepers. It is made

to fit any rail section and combines in a single piece a positive rail anchor and tie plate for keeping rails from turning over, creeping or spreading, even on heavy curves. The plate is made by the Marion Malleable Iron Works, Marion, Ind. The office of secretary and treasurer of the Positive Rail Anchor Company is in the same city.

THE INFLUENCE OF STEEL CONSTRUCTION ON FACTORY COSTS.

By Henry W. Dakin.

[Mr. Dakin is secretary-treasurer of the Detroit Steel Products Company, Detroit, Mich., maker of Fenestra solid steel window sash.]

The influence of light and air on health is now well understood. No man can do his work efficiently in an ill-lighted and ill-ventilated shop. Accuracy and speed require, not only knowledge and skill, but proper conditions under which to labor. In practically all manufacturing institutions it is well known that the day shift turns out more work and better work than the night shift. In many parts of the country the heads of large manufacturing concerns are awakening to the fact that to get the most work out of their men they must provide working conditions under which they can get the full benefit of the life-giving rays of the sun, and several well-known factories have lately been rebuilt, changing the form of construction from brick walls and wooden sash to steel construction with steel sash.

Records relating to the efficiency of men working under the two kinds of construction show clearly the good effect of daylight construction and in every instance the factory costs have been lowered since the occupation of the new buildings. For example, under the old conditions the average number of parts turned out by a man for six months was 52, and in the new factory the average was 74 a day. This increase was made by the same man with the same machine making the same kind of parts, and the increased production was the result of working under new conditions. In daylight factories men can see over and under their work and all sides of it in its true light. This of itself has a tendency to increase the rate of production.

It is essential that steel-constructed factories with large window space, be fireproof, and the steel window sash has made this possible. Solid steel window sash properly made will resist fire until the wire glass has melted away from it, and it will stop the spread of fire in a group of factory buildings, where wooden sash would soon burn out, allowing the glass to fall and permitting the flames to penetrate the interior of the building. This fact was clearly demonstrated a short time ago at a fire of the Vera Chemical Works at Stoneham, Mass. The fire started in a wooden shed in which 2,000 barrels of rosin were stored. Adjacent to this shed was a small building fitted with solid steel window sash. Although the flames and smoke from the burning rosin completely enveloped this building for hours and all hope of saving it was abandoned, little damage was done excepting the melting of a few panes of glass. The contents of the building was not damaged in the least.

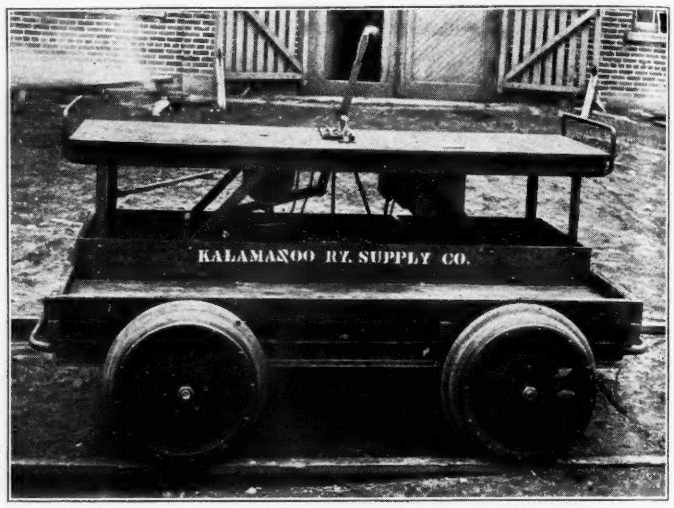
KALAMAZOO MOTOR CAR.

With the increase in attention being given to the use of motor cars for section forces by maintenance of way and operating men in general, the Kalamazoo motor car, shown by the Kalamazoo Railway Supply Company, Kalamazoo, Mich., at spaces 23, 24 and 25, in the Coliseum, is of particular interest.

The engine of this car is an air-cooled 2-cylinder horizontal engine of the reversible 4-cycle type. It is a long-stroke engine, with the resulting greater efficiency. The air-cooling is aided by the radiating flanges running lengthwise of the cylinders, increasing the cooling service three times, and also by the use of an auxiliary exhaust port, which relieves the cylinder of at least 60 per cent. of the heat left in the gases at the end of the firing stroke, and, in turn, relieves the main exhaust valves from the high temperature of these waste gases.

The engine is complete in itself and independent of the car body. The cylinders are bolted rigidly to a base containing the crank and cam shafts. All valve mechanism is part of this same unit. The transmission consists of cut steel gearing, the ratio of which can be changed to suit demands, enabling the purchaser to determine the speed at which his cars can be run. The car can be run at the same speed in both directions.

In designing this car special care was taken to see that



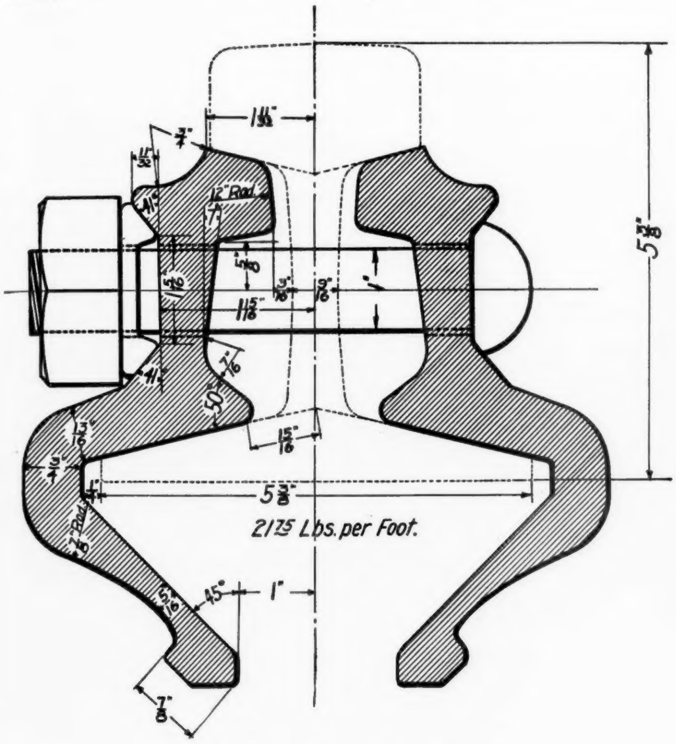
Kalamazoo Motor Car for Section Forces.

all parts requiring attention could be easily reached from the car platform. By the removal of four bolts the entire body of the car can be removed, leaving the engine and running gear exposed. The controlling levers, switch and battery box are so arranged that they can be locked when the car is not in service.

HUNDRED PER CENT. RAIL JOINT.

The Hundred Per Cent. joint is designed to provide a maximum area of section economically distributed and a depth of girder sufficient to bring its carrying capacity up to that of the rail it unites, in the belief that the weakness of the ordinary angle bar and the base plate joints is largely due to their limited girder depth. The girder depth of this joint is obtained by an inwardly inclined depending flange extending below the base of the rail at an angle of 45 deg., so as not to interfere with the tamping of the ties. The web of the joint is moved far enough from the web of the rail to permit the proper proportioning of the base member and to provide ample clearance for a square nut on a 1-in. bolt, in this way obtaining full value from this member, as well as transmitting the load to the depending flange and maintaining its position up to the full efficiency of the joint. The moving of the web of the joint from the web of the rail allows an increase in area in the head member, in addition to that of a laterally extending reinforcing rib, in this way providing metal where it is most needed to take care of the upward movement of the joint between wheel loads. This joint is equipped with a spring washer, and is made in the standard open-hearth steel and hot finish; in open-hearth steel from .45 to .55 carbon and hot finish; and in open-hearth steel from .45 to .55 carbon hot finish and oil treated. The high carbon steel increases the strength from 45 per cent. to 55 per cent., as well as retarding the cutting of the bars

under the head of the rail. The oil treatment increases the carrying capacity over the high carbon steel from 25 to 35 per cent., and also largely diminishes the corrosion of the bars.

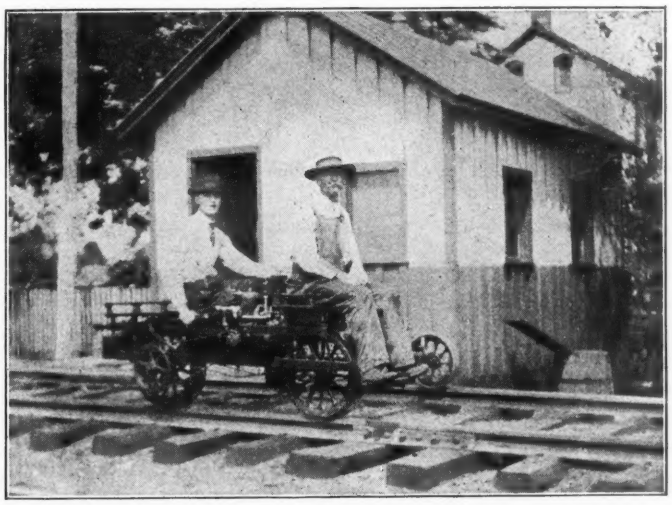


Hundred Per Cent. Rail Joint.

The Hundred Per Cent. rail joint is manufactured by the Cambria Steel Company, Johnstown, Pa., and is on exhibition in space 177 at the Coliseum.

VELOCIPEDE MOTOR CAR.

The accompanying cut shows the velocipede car of Wm. D. Tilley, signal maintainer on the Philadelphia & Reading at Lees Cross Roads, Pa., equipped with a 2½ h. p. gas engine, manufactured by the Concrete Form & Engine Company, Detroit, Mich. Mr. Tilley says that he can make 30 miles an hour with his velocipede and has never dared open it up as far as it would go, for fear of the car leaving the track. The fuel consumption for this speed is one pint of gasolene per h. p. per hour, and the lubricating oil and grease required is a very small item. Mr. Tilley has hauled the signal foreman and two of his assistants with their tool bags, which would weigh nearly as much as a fifth man. Another owner of a velocipede similarly equipped is V. C. Burgner, Philadelphia & Reading, at Hummelstown, Pa. Mr. Burgner says that his engine has held its own summer and winter, and he would not sell it for



Velocipede Equipped with Gas Engine Carrying Two Passengers.

three times its original cost if he could not get another one. Mr. Burgner says that in installing the motor all he had to do was to cut a notch on the frame for the commutator. His experience has shown that one pint of gasolene lasts five miles and that 15 cents' worth of lubricating oil and pressure grease will be enough to last eight or ten months.

Blue prints are furnished with the engine, showing how to install it, and its operation is simple enough to allow any man on the road to handle the car.

SIMPLEX SPAN BASCULE BRIDGE.

The accompanying cut illustrates a Strauss double-leaf simple span railway bridge of 336 ft. span, the construction of which will shortly be begun. This bridge is the first practical example of a double-leaf simple span structure ever built, and should be particularly interesting

Strauss Simple Span Bascule Bridge.

to railway men, as it affords a satisfactory solution of the problem of the long span bascule bridge. It is applicable to two and four track structures of lengths up to 400 ft. The center lock is a positive device which couples automatically the moment the leaves come into position. A secondary lock, involving nothing more than the ordinary end lock of the single-leaf bridge, comes into play after engagement and acts with the main lock to convert the two leaves into a single or unitary structure. One tower is placed on rollers of the usual standard type, so that the entire structure is free to expand as a whole when the bridge is closed. During operation the tower is locked in position by means of a toggle, and the process of opening and closing is then completed in the ordinary way. The reactions on the piers are vertical and constant, and divided into the leaf load and the counterweight load, as in the Strauss heel trunnion type. The Strauss simple span bascule is economical, pleasing in outline, and is adapted to conditions and situations where it heretofore has been difficult to satisfactorily use the bascule. The above design was made by the Strauss Bascule Bridge Co., Chicago.

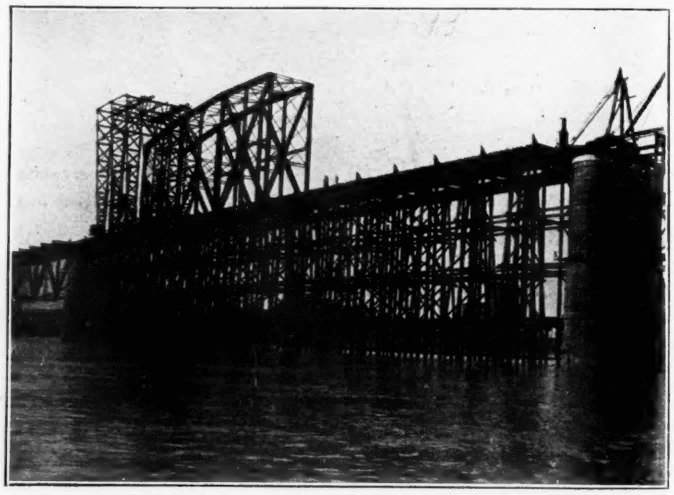
GRAIN ELEVATOR PROTECTION.

The Kansas City Southern has built a water tower to protect from fire the grain elevators at Port Arthur, Tex. The tank has a capacity of 100,000 gallons, and the height of the maximum water line is 214 ft., which gives sufficient head to throw a stream the entire height of the elevator. The water is in the tank, ready to use at the critical moment. This system does not depend on any pumps or compressors, and there is no danger that any machinery may fail at the wrong time. The certainty that the gravity tank will do that for which it is designed makes the water tower particularly adaptable to a fire protection system. The structure shown in the cut and described above was designed and built by the Chicago Bridge & Iron Works, Chicago.

Steel Water Tank for Fire Protection Service.

McKINLEY BRIDGE.

The accompanying view shows the traveler engaged in the erection of the 523-ft. span of the McKinley bridge of the Illinois Traction System across the Mississippi river at St. Louis, Mo. This structure includes three spans across the river, 521 ft., 523 ft. and 521 ft. long, respectively; two shorter river spans of 250 ft. in length each, and three shore spans of 150 ft. each, together with steel elevated approaches on each end. The entire length of the bridge and approaches is over 8,000 ft. The three main river spans are riveted through Pratt trusses, while the five shorter spans are riveted deck trusses. The total width over all is 65 ft., the clearance above high water 50 ft., and above low water 85 ft. The four large river piers are built of red granite and Bedford limestone backed with



Erecting 523-ft. Span of McKinley Bridge at St. Louis.

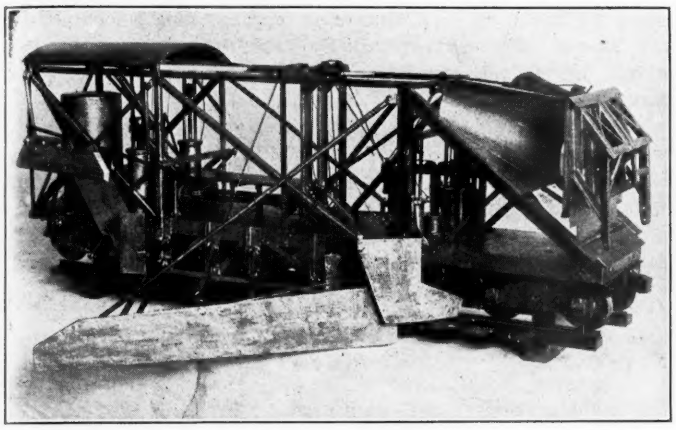
concrete. They are 150 ft. from the bedrock to capstone, 26 ft. thick and 76 ft. wide at the bottom. This structure was formally opened on November 10, 1910, and is now in regular service. This structure was erected by the Missouri Valley Bridge & Iron Company, Leavenworth, Kan.

KENNICOTT SPREADER.

The Kennicott Company, Chicago Heights, Ill., manufactures a combination machine that can be used as a bank shaper, snow plow, bank builder, ballast spreader, grain elevator, ditcher and flanger.

The accompanying cut shows the Kennicott spreader. The main spreader wings are operated by opening two air cocks. The wings lock down automatically and are released by the operator applying his foot to pedal and applying the air to cylinders. There are no struts or braces to put in or take out. The folding snow plow is built strong enough to stand the work and is carried in folded position when not needed. When required it can be lowered to position and secured ready for work in ten minutes. The 24-inch plows are built of cast steel thick enough to give the required strength, and the use of plow share, mold board and landslide,

makes a plow that will plow a furrow and not drag through the ground. The ingathering wings are used for taking filling ballast material from the sides of track for raising grades, ballasting track, etc. The bank shapers make it possible to shape up banks to a true surface, shoulder and bank slope, which is an expensive task for section men. The flanger blades attached to ingathering wings when



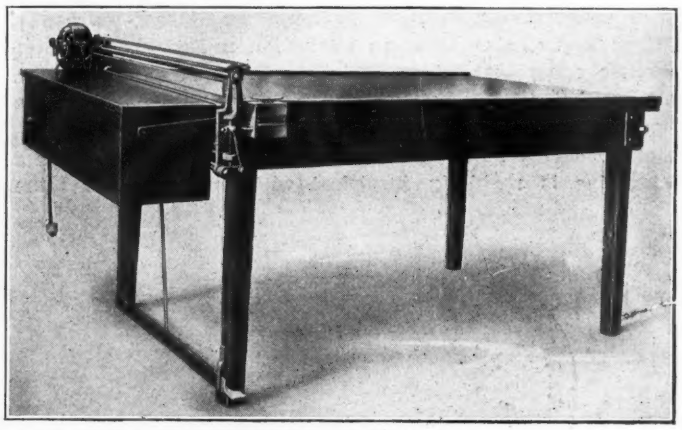
Kennicott Spreader.

lowered form a perfect flanger operated by air; to be used when snow plow is in service or separately as desired. The bank builder makes it possible to raise grades eight feet parallel with track, and also build up areas to that height without using piling to build tracks on. At a small additional cost the roof can be extended the entire length of the car and the sides closed up, furnishing a compartment for carrying tools which might be desirable in some instances. The ingathering wings form center dump ballast spreading wings when car is moved ahead, and set of wings immediately ahead perform same service when car is run in opposite direction. The complete machine weighs 94,000 lbs.

PEASE MOTOR DRIVEN CUTTING AND TRIMMING TABLE.

The accompanying illustration shows the Pease motor driven cutting and trimming table, arranged with a light-proof box for blue print paper. This trimming table will be found a great convenience to all makers of blue prints, and it can also be used to excellent advantage for cutting tracing paper or cloth, detail paper, etc. The table is provided with a parallel clamp, operated with a foot treadle, which holds the paper, tracing cloth or print securely while the revolving cutting knife is used. This device is rapid and convenient in operation and will trim a very narrow strip from the paper or print. The revolving cutting knife is motor driven and is rotated positively by mechanical means not depending on friction against blade or paper, and therefore will cut the thinnest paper or will cut five to ten sheets at once. The knife is electrically operated in either direction at will, is stopped or started at any point by a specially designed wrist-controlled switch which leaves both hands of the operator free to handle the paper or prints. The table is of hardwood, with metal trimmings, arranged to be easily knocked down for shipment. Electric equipment is complete and is arranged so it can be connected to any incandescent light socket. The top of the table is scored in inches and is provided with figures along the front edge, so that any size sheet can be measured. A sizing diagram can also be provided for the top of the table, which gives at a glance the size of any tracing or print and the square foot measurement.

These tables are also furnished with a basket on the end in stead of a light-proof box, designed for cutting prints after they have been run in an automatic printing, washing and drying machine. The tables as regularly furnished are 4 ft. wide by 6 ft. long, but any width up to 8 ft. can be supplied. This table is also furnished in widths up to 42 in., arranged for operating the cutting knife by hand instead of with motor. The cutting machinery is all self-contained and can be furnished separately if desired, so it can be



Pease Cutting and Trimming Table.

bolted on any table of appropriate width, and the cutting device can be used with or without the parallel clamp. This table can be seen in operation at the Coliseum at the exhibit of the C. F. Pease Company, Chicago, in sections 161-162.

WATER STATION APPARATUS.

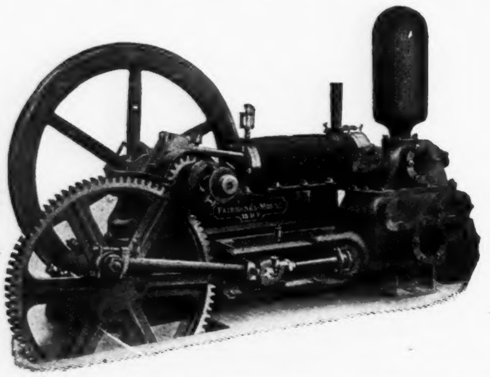
Fairbanks, Morse & Co., Chicago, have on exhibition at the Coliseum an Eclipse double-acting pump, a 10-in. and 7-in. x 12-in. duplex steam pump, and a 10-h.p. combined gasoline engine and pump as one unit on one solid base. These pumps are only a few of the complete line of pumping machinery carried by this firm in addition to the complete water stations which it builds.

The internal combustion engine has found a large field on account of economy in operation, and the makers say that the railways are rapidly adopting the combined pumper for water stations wherever possible. This pumper is made in sizes from 5 to 25-h.p., with capacities from 55 to 495 gallons per minute. The pump is rigidly attached to the engine frame, making a compact, self-contained unit requiring only an ordinary foundation and ordinary pipe connections. A pinion on the main crank shaft meshes with a large gear which operates the pump, this large gear being arranged to give three different lengths of stroke. A friction cone clutch is provided so that the engine may be started independently of pump and under no load. This clutch is operated by a long lever, permitting its use without possibility of danger to operator. The pump is so constructed as to permit a large range of capacity and use in handling different liquids. When desired an automatic stopping device can be furnished which will shut down the engine when tank or standpipe is full, open the drain cocks of water cylinder and cooling pipe connections, shut off fuel supply and disconnect batteries. This is one of the features that makes the gasoline pumper a desirable and economical proposition, as the station agent or section foreman can attend to it, simply starting the engine, which will stop when the tank is filled, or one waterworks man can easily take care of three or four stations.

For deep-well pumping, Fairbanks, Morse & Co. have designed a "geared base" engine. This is a standard internal combustion engine, made in sizes 5 to 15 h.p., with a large gearwheel to which is connected a pitman rod for operating

a deep well pump. This machine is also fitted with extended shaft and pillow blocks when desired to place it away from the well, and the large gear is also provided with suitable means whereby several lengths of stroke can be had to accommodate the requirements of the well. Both the combined pumper and the geared base engine can be furnished to operate on gasoline, gas, kerosene, alcohol, crude oil or distillate.

In connection with their pumping machinery, Fairbanks, Morse & Co. also have on exhibition a No. 10, 10-in. telescopic spout standpipe. This standpipe is equipped with a water-balanced valve, which means that the water is on both sides of the valve and at the same pressure as in the main, insuring no leakage and a minimum amount of wear. The pipe is regularly furnished with an automatic relief



Fairbanks-Morse Combined Gasoline Engine and Pump.

valve which prevents water hammer, which is so destructive to pipe lines and tanks. The telescopic spout feature will accommodate the largest or smallest engines, with no waste or dripping of water. This is an important factor if the water station is barely large enough for requirements, and it also prevents softening of track by dripping water. The No. 10 standpipe is a one-man standpipe and does not require the baggageman or head brakeman to unlock it from the ground and turn it around for the fireman. The pipe is securely locked parallel with the track and can be unlocked and turned by the fireman on the tender without help from the ground. When the engine is watered the pipe will automatically lock in position when swung back from the tender.

Catalogue No. 126-A, issued by Fairbanks, Morse & Co., describes their pumping machinery, water stations, etc., completely.

FRANKLIN GASOLINE-DRIVEN AIR COMPRESSORS.

The substitution of power-operated machinery for manual labor has not been carried as far in maintenance of way work as most other departments of railway engineering. This applies particularly to the use of compressed air tools, now considered indispensable in the shop, and is due largely to the fact that maintenance of way work at any particular point is usually of short duration, and the time required to set up and put in operation a steam-driven air compressor, with its accompanying boiler, is greater than the saving to be effected by the use of pneumatic tools will warrant. The Chicago Pneumatic Tool Company, Chicago, has recognized the need in this field and its Franklin gasoline-driven compressor is designed to supply the demand for a compressor for small installations.

This machine has many features which recommend it for this class of work. The absence of the boiler makes the first cost of plant and equipment much lower than with a steam plant, and perhaps an even greater advantage is the reduced weight and portability. The whole machine is extremely simple and compact, there being no gearing as found in the few gasoline outfits previously available, even that ordinarily required for the valve gear having been eliminated. The engine is of the two-cycle type, there being no valves to leak or adjustments to be tampered with. In addition, since with a two-cycle engine an impulse is received each revolution, the weight of fly-wheels necessary with the four-cycle type can be reduced. Since the impulses are received twice as often as in a four-cycle engine, and consequently the forces are correspondingly less, a reduction in the weight of various parts transmitting power to the shaft is possible.

The elimination of boiler, water and coal supply is a matter of considerable importance in a portable outfit, and in addition to this there is a further advantage in reduction of fuel expense, due not only to greater efficiency in the use of fuel, but also to the fact that there are no "stand-by" losses, the fuel consumption beginning with the work and ceasing immediately upon its completion.

CONCRETE MIXER LIFTING ATTACHMENT.

In constructing piers, abutments and walls in railway work it is often necessary to deposit the concrete at a considerable elevation above the ground. The accompanying illustration shows the way in which such a problem was solved by the use of equipment of the Municipal Engineering & Contracting Company, Chicago. A Chicago improved

Chicago Improved Cube Mixer, With Lifting Attachment.

cube mixer was placed on a platform built at such a height that it could discharge directly into the wall and a charging elevator was built to the ground. This elevator was filled in the usual way at the ground level and carried to the top, where it was discharged directly into the mixer. In this instance the material was delivered to the mixer at the rate of 1⅔ batches per minute, and the machine kept in constant operation ten hours a day for sixty days without a breakdown.